DRAFT FOR FEDERAL AND STATE REVIEW

Allied Paper, Inc./Portage Creek/
Kalamazoo River Superfund Site

Allied Paper, Inc. Operable Unit

Feasibility Study Report

Millennium Holdings, LLC

October 2009

ARCADIS

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Acronyms and Abbreviations

AOC	Administrative Order by Consent
AMSL	above mean sea level
ARARs	applicable or relevant and appropriate requirements
ATSDR	Agency for Toxic Substances and Disease Registry [
BBL	Blasland, Bouck & Lee, Inc.
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COCs	constituents of concern
cy	cubic yards
FML	flexible membrane liner
FRDLs	Former Residuals Dewatering Lagoons
FS	Feasibility Study
GCL	geosynthetic clay liner
GDC	geosynthetic drainage composite
GRAs	General Response Actions
GSI	groundwater-surface water interface
HRDL	Historic Residuals Dewatering Lagoon
IRM	Interim Response Measure
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
mg/kg	milligrams per kilogram
MHLLC	Millennium Holdings, LLC
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NHTSA	National Highway Traffic Safety Administration
NREPA	Resources and Environmental Protection Act
O&M	operation and maintenance
OU	Operable Unit
PCBs	Polychlorinated biphenyls
PRGs	preliminary remedial goals
RAOs	remedial action objectives
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision

SARA	Superfund Amendments and Reauthorization Act
SVOCs	semi-volatile organic compounds
TAL	target analyte list
TBC	to be considered
TCL	target compound list
TCRA	Time-Critical Removal Action
TSCA	Toxic Substances Control Act
USDOL	United States Department of Labor
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds
µg/L	micrograms per liter

1. Introduction

The Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site (Site or Superfund Site), located in Kalamazoo and Allegan counties in southwest Michigan (Figure 1-1), has been the subject of investigation and cleanup activities since the early 1990s. The Site is large and complex – spanning nearly 80 miles of the Kalamazoo River between Morrow Dam and Lake Michigan, and including a stretch of Portage Creek from Cork Street to its confluence with the Kalamazoo River, several former paper mill properties, and several former disposal areas. As a result, it was divided into a series of Operable Units so that investigation and response work could proceed for different areas of the Site on independent timelines.

One of these Operable Units is the Allied Paper, Inc. Operable Unit (Allied OU, also referred to as OU1), which encompasses 89 acres along Portage Creek between Cork and Alcott streets within the City of Kalamazoo. ARCADIS (formerly Blasland, Bouck & Lee, Inc. [BBL]) has conducted work at the OU on behalf of Millennium Holdings, LLC (MHLLC)[1]. Between 1991 and 2007, these efforts were carried out in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1996, and pursuant to an Administrative Order by Consent (AOC) issued by the State of Michigan in 1991 (Final Order No. DFO-ERD-91-001). The 1991 AOC was terminated in September 2007, and although there is currently no effective AOC applicable to the Allied OU, the United States Environmental Protection Agency (USEPA) and MHLLC have agreed to proceed and complete the Feasibility Study (FS) for the Allied OU.

This *Feasibility Study Report* (FS Report) presents the results of a process to assemble and evaluate a series of representative cleanup options for the Allied OU. This report describes the steps taken by MHLLC to examine potential General Response Actions (GRAs), evaluate remedial technologies, develop alternatives to address OU-specific potential risks to human health and the environment, and evaluate the alternatives relative to the nine criteria established under CERCLA (USEPA 1988). The results of the *Allied Paper, Inc. Operable Unit Remedial Investigation Report* (RI Report; Michigan Department of Environmental Quality [MDEQ] 2008) and recent supplemental investigation work were considered and incorporated throughout the process.

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[1] LeMean Property Holdings Corporation (LeMean) owns the Allied Paper, Inc. Operable Unit. LeMean is a wholly owned subsidiary of MHLLC. MHLLC is directing the work at the Allied OU on behalf of LeMean.

This FS Report includes the following elements:

- Section 1: Summary of the background and history of the Allied OU, a summary of key elements in the RI Report (MDEQ 2008), findings of the recent Supplemental Groundwater Study, presentation of USEPA's Preliminary Remedial Goals (PRGs), identification of constituents of concern, and a summary of the groundwater extraction and treatment system.

- Section 2: Identification and development of possible federal and state applicable or relevant and appropriate requirements (ARARs); establishment of remedial action objectives (RAOs); and identification of GRAs.

- Section 3: Identification and screening of technologies and process options; and assembly of a range of alternatives designed to achieve the risk-based RAOs established for the OU.

- Section 4: Descriptions of the range of remedial alternatives developed for the OU.

- Section 5: Detailed individual analysis of each alternative relative to a series of evaluation criteria defined in CERCLA.

- Section 6: Comparative analysis of the alternatives relative to the CERCLA evaluation criteria.

- Section 7: References used in the development of this report.

A preliminary list of alternatives was presented to USEPA and the public at a public meeting on September 10, 2009. Subsequent to the meeting, MHLLC and USEPA discussed the preliminary alternatives, and the alternatives presented in Section 3 reflect modifications incorporated based on input received at the public meeting and the follow up discussions. USEPA will use the assessment of remedial alternatives presented in this FS Report to select a final remedy for the OU.

1.1 Background and History

The Allied OU is located within the City of Kalamazoo, and includes areas that are zoned for industrial, commercial, and residential purposes (see Figure 1-2). Alcott Street runs along the northern end of the OU, and Cork Street forms the southern boundary. Industrial and commercial properties are located north and south of the OU and along portions of the eastern and western sides of the property. Residential development exists along a portion of the eastern side of the OU, and a railroad corridor forms the boundary along a portion of the western side of the OU.

The OU was the site of the Bryant Paper Mills, which were built by the Bryant Paper Company in 1895. The Monarch Mill, built by the Kalamazoo Paper Company in 1875 was not located within the boundaries of the OU, but residual materials from the manufacturing process at Monarch were handled in one portion of the Allied OU. A variety of paper manufacturing, recycling, and disposal operations were conducted at the OU until the late 1970s and early 1980s, when all paper manufacturing operations ceased. No active mills remain at the OU, and all the mill-related buildings have been razed.

Polychlorinated biphenyls (PCBs) were introduced to the OU through the recycling of carbonless copy paper that contained PCBs as a carrier for the ink. Carbonless copy paper contained PCBs between 1957 and 1971, and PCBs remained in the recycle stream after that period as the carbonless copy paper supply was depleted. The key risk management goals established for the Allied OU are associated with addressing the potential risks associated with exposure to PCBs in various media.

Paper-making residuals (residuals) were the primary waste product generated during the paper manufacturing and recycling process at the mills. These residuals, which are primarily a mixture of organic clay and wood fiber, often have the visual appearance of gray clay. As with most clays, the residuals have low permeability when compacted. The visual appearance of residuals is distinctive, and a goal of some excavation activities completed to date at the OU has been to remove all the visible “gray clay” residuals.

The Alcott Street Dam was built in 1895 to provide hydroelectric power and process water for the Bryant Paper Mills, and impounded Portage Creek to form the Bryant Mill Pond. As described in the RI Report (MDEQ 2008), Allied Paper Company obtained a permit (No. 75-12-187) from the Michigan Department of Natural Resources (MDNR) to draw down the reservoir in 1976 in an effort to reduce loading impacts to Portage Creek; this drawdown narrowed the creek channel and exposed sediments that had accumulated over the many years of mill operations. The dam is currently owned by MHLLC and is classified as a high hazard structure (ARCADIS BBL 2006). Surface water in Portage Creek is at an elevation approximately 13 feet lower than before the drawdown, and the gates have been permanently removed. The dam was last inspected by MHLLC in May 2006 and the next inspection is scheduled for December 2009.

1.2 Sub-Areas of the Allied OU

To aid in the characterization of the OU and the development of previous investigation and future cleanup efforts, the OU was previously divided into a number of individual sub-areas based on historical operations. These sub-areas, depicted on Figure 1-2 and described in detail in the RI Report (MDEQ 2008), are:

- **Former Operational Areas –** includes the following sub-areas: Bryant Historic Residuals Dewatering Lagoon (HRDL) and Former Residuals Dewatering Lagoons (FRDLs), Monarch HRDL (including the Former Raceway Channel), Type III Landfill, and the Western Disposal Area (which includes peripheral portions of the Panelyte Marsh and Panelyte Property, the Conrail Railroad Property, and the State of Michigan's Cork Street Property, referred to in this report as the Peripheral Areas).

- **Former Bryant Mill Pond Area –** includes the area within the boundary of the Former Bryant Mill Pond, defined by a historical impoundment elevation of 790 ft above mean sea level (AMSL).

- **Residential and Commercial Properties –** includes the following sub-areas: Clay Seam Area, Former Filter Plant, East Bank Area, four adjacent residential properties (Golden Age Retirement Community and three single-family residences); three commercial properties (Goodwill, Consumers Power, and MHLLC's Alcott Street Parking Lot); and MHLLC-owned property used by owners of the three single-family residences. These areas are referred to in this report collectively as the Outlying Areas, which are separate and not contiguous with the onsite Former Operational Areas that contain the majority of PCB-containing materials.

PCBs are present in soils and/or residuals near or at the ground surface in certain sub-areas of the OU, and in other areas they are present only beneath buildings, pavement, soil, and/or clean fill materials that serve as barriers to exposure and transport. Examples of the latter include the Alcott Street Parking Area, portions of the Goodwill property, and the private residential properties, where the available data indicate there is a minimum of 4 feet of clean fill on top of the residuals. As discussed in detail in the following section, the Bryant HRDL/FRDLs area also is covered with barrier materials, consisting of a composite landfill cap with several feet of engineered cover materials.

The presence of PCBs has not been confirmed on parcels owned by Consumers Power, the Golden Age Retirement Community, and certain single-family residential parcels. In the absence of additional information, in the RI Report it was conservatively assumed that PCBs are present in these areas, until and unless future delineation efforts prove otherwise. To clarify this situation, it is expected that additional sampling/soil boring efforts would be carried out before finalizing the cleanup approach for the OU to either confirm the absence of PCBs or delineate the extent of PCB-containing soils/residuals.

1.3 Summary of Prior Response Actions

The Allied OU was designated as a distinct unit within the Superfund Site in part so that cleanup activities could proceed on a separate time table from the remedial activities developed for the Site as a whole. Between 1998 and 2004, a series of response actions were completed that have significantly reduced the extent of PCB contamination and stabilized the majority of PCB-containing materials at the OU. The primary actions performed to date are summarized below.

1.3.1 Time-Critical Removal Action at the Former Bryant Mill Pond

In 1998 and 1999, the USEPA completed a Time-Critical Removal Action (TCRA) at the Former Bryant Mill Pond. This work involved the excavation of 146,000 cubic yards (cy) of PCB-containing sediments, residuals, and soils and placement of these materials into the Bryant HRDL and FRDLs (Weston 2000).

The initial excavation was performed with a PCB concentration action level of 10 milligrams per kilogram (mg/kg), and a goal of achieving post-excavation PCB concentrations less than or equal to 1 mg/kg. At locations where initial post-excavation PCB sampling results exceeded this goal, an additional 6 inches of material was removed. The USEPA then backfilled the excavated area with an amount of clean fill approximately equal to the volume of materials removed. The thickness of the backfill layer ranged from approximately 1 foot at the upstream end of the Former Bryant Mill Pond to approximately 10 feet near the Alcott Street Dam. The surface of the materials placed in the Bryant Mill Pond was graded, seeded and revegetated with native grasses and plants, and the habitat was restored.

Although the majority of post-excavation samples were below the target PCB concentration of 1 mg/kg established for the TCRA (Weston 2000), not all the samples were below a 0.33 mg/kg screening level criterion MDEQ applied in the RI Report (MDEQ 2008). As all of the excavated areas were subsequently backfilled with 1 to 10 feet of clean fill and fully restored with native vegetation, residual exposures in the removal areas have been addressed and no additional remedial actions are contemplated for the Former Bryant Mill Pond Area. This approach aligns with the cashout agreement for the TCRA at the Former Bryant Mill Pond, in which the USEPA agreed that no further remedial actions will be required of MHLLC at the Former Bryant Mill Pond based on the completed activities (USEPA 1998).

1.3.2 Interim Response Measures

Beginning in the early to middle 1990s, MHLLC conducted a series of small-scale Interim Response Measure (IRM) activities to restrict access to the OU and provide erosion control and stabilization in certain areas. MHLLC also removed remnant structures, such as the Filter Plant, from the historical mill operational areas. The former Bryant Clarifier remains in place. The various components of the IRM are described in the following sections.

1.3.2.1 Bryant HRDL and FRDLs

After completion of the Bryant Mill Pond TCRA, MHLLC carried out IRM activities to stabilize the area where USEPA disposed of the materials excavated from the Former Bryant Mill Pond and to further mitigate the exposure to or transport of PCBs at the Allied OU. These IRM activities completed at the Bryant HRDL/FRDLs included the following:

- Installation of approximately 2,600 linear feet of sealed-joint sheetpile along the western bank of Portage Creek to stabilize the perimeter berms that separate the materials in the Bryant HRDL and FRDLs from the Portage Creek floodplain (see Figure 1-2). This response action was completed in 2001.

- Removal of several hundred cy of soil containing residuals from locations between the sheetpile wall and Portage Creek, and consolidation into the Bryant HRDL and FRDLs. This material was removed in 2000 and 2003 to minimize the potential for PCB releases to Portage Creek.

- Construction of an engineered composite landfill cap for the Bryant HRDL and FRDLs designed based on Michigan Act 451, Part 115 solid waste regulations. The cap design consists of six layers from the bottom of the cap to the top (at the ground surface). The layers are: a non-woven geotextile, a 12-inch thick (minimum) sand gas venting layer, a 30-mil polyvinyl chloride flexible membrane liner (FML), a geosynthetic drainage composite layer, a 24-inch thick (minimum) drainage and soil protection layer, and 6-inch thick (minimum) vegetated, topsoil layer. This cap, which covers the Bryant HRDL and FRDLs, was constructed between 2000 and 2004.

- Design and installation of a groundwater recovery system to mitigate mounding of shallow groundwater behind the sheetpile installed in the berm along Portage Creek. The groundwater recovery system includes two recovery wells and ten sumps – six of which drain a series of horizontal recovery trenches and four individual sumps along the sheetpile wall (Figure 1-3). The water recovered by this system is currently treated onsite by an activated carbon treatment system and then discharged to the City of Kalamazoo publicly-owned treatment works in accordance with a wastewater discharge permit. The treatment system was added as a precautionary measure in case the recovered groundwater contained PCBs at concentrations greater than the MDEQ groundwater-surface water interface (GSI) criterion of 0.02 micrograms per liter (µg/L). However, PCBs have not been detected in the water coming into the treatment system above the reporting limit in the four years it has been monitored. The performance of the groundwater recovery and treatment system is discussed further in Section 1.8 (Groundwater Extraction and Treatment).

As a result of the IRM activities listed above, a total of approximately 89,600 cy of PCB-containing soils, sediments, and residuals were consolidated beneath the landfill cap. (This volume was added to the 146,000 cy of material excavated and consolidated during the Former Bryant Mill Pond TCRA.) The cap acts as a barrier to minimize the potential for transport of PCBs, mitigates the potential for direct contact with PCBs, and virtually eliminates the infiltration of precipitation that might form leachate. As stated in the Settlement Agreement and Modifications to Action memorandum for the Bryant Mill Pond Area TCRA (USEPA 1998), "Region 5's proposed action will …be consistent with what Region 5 currently anticipates will be the final remedial action for the Operable Unit." Ongoing site inspections, cap maintenance, groundwater elevation monitoring and landfill gas monitoring have been performed by MHLLC and will be continued at the Bryant HRDL/FRDLs sub-area.

1.3.2.2 Portage Creek Floodplain

In 2002, MHLLC conducted an IRM to remove approximately 1,700 cy of residuals located in the floodplain on the eastern side of Portage Creek (referred to as the East Bank Area – see Figure 1-2) and PCB-containing soils between the sheetpile and the creek. These materials were consolidated into the Bryant FRDLs prior to construction of the landfill cap. The IRM methods and cleanup targets were identical to those used by USEPA during the TCRA. Results of all post-excavation confirmation samples were below the target PCB removal criterion of 1 mg/kg, and the excavation was backfilled with a minimum of 1 foot of clean fill. The area was subsequently seeded and revegetated with native plants to restore the existing habitat.

Given the IRM actions taken to date, no additional remedial actions are planned for the East Bank or other floodplain areas that were addressed by IRM actions along Portage Creek.

1.3.2.3 Filter Plant

The Filter Plant, which occupied a small parcel of land that is surrounded on all sides by the Panelyte Property (see Figure 1-2), was demolished in 2006 by MHLLC. During the demolition activities, a small volume of paper sludge was removed from the area, solidified, and disposed in the Western Disposal Area. Structures in the building were cleaned and sold to recycling facilities or disposed at a licensed solid waste disposal facility. Standing water within the basement was sampled for PCBs, and all results were non-detect.

Consistent with the City of Kalamazoo building code, the building foundation was removed to a minimum depth of 2 feet below grade. The foundation area was backfilled with clean fill (several feet of sand and a 6-inch layer of topsoil) and seeded to promote revegetation.

Due to IRM actions taken to date, no additional remedial actions are planned for the Filter Plant property.

1.4 Summary of the Remedial Investigation

The RI Report (MDEQ 2008) describes the extensive body of data collected between 1991 and 2003. Some data collected early in the investigation process can no longer be used to describe current conditions at the OU because the completion of the prior response actions described in Section 1.3 resulted in significant changes in the nature and extent of contamination. However, as stated in the RI Report, the available data that are representative of current conditions are “sufficient to complete the FS, assess the present state of the OU, and inform decisions on future remedial actions” (MDEQ 2008). Summaries of the data included in the RI Report regarding the nature and extent of PCBs at the OU that can be used to describe current conditions and the key mechanisms of PCB fate and transport are presented below. The data in the RI Report, which have been augmented by data from the Supplemental Groundwater Study (ARCADIS 2009b), have been considered in the development and analysis of alternatives presented in this FS Report. The Supplemental Groundwater Study is summarized in Section 1.5.

1.4.1 Nature and Extent of PCBs

The physicochemical properties of PCBs (i.e., high octanol-water partitioning coefficient, high organic carbon partitioning coefficient, low Henry's Law constant value) result in their tendency to bind to organic matter very quickly and very strongly, and to not volatilize into the air. Because PCBs tend to adsorb strongly to soil, they are unlikely to partition to groundwater once adsorbed (Agency for Toxic Substances and Disease Registry [ATSDR 2000]). Thus, although PCBs have been detected in various environmental media in certain portions of the Former Operational Areas, the Former Bryant Mill Pond Area, and the Residential and Commercial Properties, they are most often found associated with onsite soils and residuals. Where present, PCBs are found at low concentrations in sediment, groundwater, leachate, and groundwater seeps.

The discussion of nature and extent in the RI Report has been updated for the purposes of the FS. The data for residuals, soil, groundwater, groundwater seeps, sediments, and surface water representative of current conditions were assessed relative to Act 451 Part 201 screening criteria in Section 1.7, and PCB concentrations are compared to PRGs established by USEPA (CH2M Hill 2009) in Section 2.1. These assessments were used to help shape the development of the range of remedial alternatives presented in Section 3.

The data presented in the RI Report for air, surface water, and biota are not summarized in this FS Report because, as determined by USEPA (CH2M Hill 2009), those media will be indirectly addressed in the development of alternatives. No alternatives specific to those media are developed in this FS, so the associated data are not relevant to this report. The USEPA's evaluation of media and potential exposure pathways at the OU is discussed further in Section 1.6.

1.4.2 Fate and Transport of PCBs

In the final version of the RI Report (MDEQ 2008), MDEQ identified the primary mechanisms of PCB fate and transport at the Allied OU: PCB transport in groundwater, PCB transport from surface water runoff and soil erosion, PCB transport in Portage Creek, PCB transport in air, and PCBs in fish. The potential for bioaccumulation of PCBs from sediment into fish/biota tissue is of primary concern, as it most directly affects the key exposure pathway of concern – the consumption of PCB-containing fish. The description of the mechanisms as presented in the RI Report is briefly summarized below. The relevance of each mechanism to the development of the FS is also described.

PCB transport in groundwater. PCBs were detected in historical samples of groundwater, leachate, and groundwater seeps at the Allied OU prior to the TCRA and IRM activities. More recently, PCB detections have been confined to seeps in areas that are located in the immediate vicinity of or in direct contact with PCB-containing residuals. Addressing the sources of PCBs to groundwater and improving the overall quality of groundwater at the OU was a consideration in the development of potential remedial alternatives. These include alternatives that address sources of PCBs to groundwater indirectly by reducing the formation and/or migration of leachate.

PCB transport from surface water runoff and soil erosion. There are portions of the OU (primarily in the Former Operational Areas) where PCBs are present in surficial soils and residuals, and these materials may be transported to the floodplain or sediments in Portage Creek via erosion and runoff. This transport pathway has been addressed in the development of potential alternatives.

PCB transport in Portage Creek. As described in the RI Report (MDEQ 2008), the most significant historical source of PCBs to Portage Creek from the Allied OU was the discharge of PCB-containing residuals at the Former Bryant Mill Pond. The excavation of PCB-containing sediments, residuals, and soils and subsequent replacement with clean fill in the Former Bryant Mill Pond has isolated these materials from direct contact with surface water, and permanently removed the largest source of PCBs to Portage Creek at the Allied OU. Under current conditions, the remaining potential sources of PCBs to Portage Creek from the OU are primarily associated with the erosion of contaminated soils and sediments. These pathways have been addressed in the development of remedial alternatives.

PCB transport in air. PCBs were not detected in air above the action or alert levels during the Former Bryant Mill Pond excavation or drying activities (Weston 2000), and no extensive air monitoring was required during the IRM activities. As described in the RI Report, although PCBs may still be exposed at the surface at some locations within the Former Operational Areas, completion of the prior response actions has greatly reduced the surface area where PCB-containing materials are exposed, and therefore have reduced the potential for PCBs to be released into the air. Air is a not a medium of concern from a remedial perspective and USEPA did not establish a PRG for PCBs in air (CH2M Hill 2009). However, PCBs in air will be monitored as necessary during any future remedial work to account for the potential short-term impacts associated with implementation.

PCBs in fish. Fish that come in sustained contact with PCB-containing sediments may bioaccumulate PCBs in their fatty tissue. Through this bioaccumulation, human and ecological receptors who consume fish may then be exposed to PCBs. Although the presence of PCBs in fish has been of primary concern for the overall Superfund Site, at the Allied OU, USEPA expects that addressing PCB sources in soil, sediment, and groundwater will result in the achievement of risk-based goals for fish in Portage Creek (CH2M Hill 2009). As a result, USEPA did not establish a PRG for PCBs in fish (CH2M Hill 2009), and the potential for PCBs to bioaccumulate in fish is not directly addressed in this FS Report. The mechanisms associated with transport to soil, sediment, and groundwater have been addressed in the development of potential alternatives.

1.5 Supplemental Groundwater Study

At the request of USEPA, in 2009 MHLLC completed a groundwater assessment to evaluate the potential for impacted groundwater at the Allied OU to migrate to the City's drinking water wells (ARCADIS 2009b). This Supplemental Groundwater Study included an evaluation of existing data from the Allied OU and the nearby Strebor facility, and review of a groundwater flow model developed by the City (City of Kalamazoo 1999) to preliminarily evaluate the likelihood of a complete migration pathway from the Allied OU to the City's Central Well Field. The assessment of existing data suggested that, based on the presence of a laterally extensive aquitard and an upward vertical hydraulic gradient between the regional aquifer (used by the City for potable purposes) and the shallow aquifer, such a groundwater migration pathway to the City's Central Well Field is unlikely.

The second phase of the study included the collection and analysis of groundwater elevations obtained from wells located on the Allied OU and the Strebor, Panelyte, and Performance Paper properties to more quantitatively evaluate the potential for groundwater from the Allied OU to migrate offsite or to the City's Central Well Field. The groundwater elevation data supported the conceptual understanding that:

- There is a strong upward gradient from the lower regional aquifer upward toward the surficial aquifer
- Shallow groundwater flow from adjacent properties to the east and west is directed onto the Allied OU
- Portage Creek is the point of discharge for shallow groundwater from the Allied OU

Further empirical support for the conceptual site model was provided by the analytical results for water samples collected by the City from its own production wells. There have been no detections of PCBs in the City's samples, not even at trace levels that are well below both standard analytical methodologies and applicable water quality standards.

In summary, the results of the Supplemental Groundwater Study provide a reasonable basis to conclude that there is no groundwater migration pathway from the Allied OU to the City's Central Well Field.

The complete report is included as Attachment 1.

1.6 Summary of Preliminary Remedial Goals

In March 2009, USEPA developed a technical memorandum (PRG Memo; CH2M Hill 2009) that established a series of PRGs for the Allied OU. As described by USEPA, these PRGs were compiled after considering ongoing sources, release mechanisms, impacted media, potential exposure routes, and potential human and ecological receptors present at the OU. There are a series of quantitative PRGs and one qualitative PRG included in the March 2009 memorandum. The quantitative values are based on risk-based criteria described in the human health and ecological risk assessments developed for the Superfund Site (CDM 2003a and 2003b) and other relevant risk-based regulatory criteria. These quantitative PRGs were developed based on the understanding that PCBs are the driver of potential risks at the OU. USEPA (CH2M Hill 2009) also recommended the application of a qualitative PRG that requires either remedial action where residuals are visually observed, or sufficient sampling to verify that the residuals do not contain PCB concentrations above applicable goals.

USEPA completed an assessment of potentially complete exposure pathways and relevant receptors (CH2M Hill 2009). Of these pathways, the drinking water pathway was considered to be incomplete at the OU. In the PRG Memo, USEPA recommends that remedial alternatives include controls to prohibit the installation of drinking water wells onsite to prevent the completion of this pathway in the future.

The PRGs recommended to achieve risk-based goals at the Allied OU are summarized in Table 1-1, below. The PRG Memo is included as Attachment 2.

Table 1-1
Summary of Preliminary Remedial Goals Established by USEPA (CH2M Hill 2009)

Medium	Pathway		PCB PRG
Soils	Human Health	Residential	2.5 mg/kg
		Commercial/Industrial	16 mg/kg
		Recreational	23 mg/kg
	Ecological	Aquatic	0.5-0.6 mg/kg
		Terrestrial	6.5-8.1 mg/kg
Sediments	Human Health	Fish Consumption	0.33 mg/kg
	Ecological	Aquatic	0.5-0.6 mg/kg
Groundwater (including seeps)	Human Health	Direct Contact	3.3 µg/L
	Groundwater-Surface Water Interface		0.2 µg/L
Residuals	N/A		Qualitative: Where a removal is proposed, all visible residuals are to be removed unless analytical data are available to confirm PCBs (if present) are below applicable criteria

Notes:
1. The sediment PCB criterion of 0.33 mg/kg is to be applied to inundated areas based on an applicable inundation period that has not yet been defined. Therefore, this criterion is not currently applied.
2. mg/kg – milligrams per kilogram
3. µg/L – micrograms per liter
4. N/A – not applicable

The PRGs listed above were considered in the development of the potential remedial alternatives in Section 3. As discussed in more detail in Section 2, the relevance of a particular PRG in a specific area of the OU depends on the media present, current and future land use, and the presence of potentially complete exposure pathways and receptors. A current land use figure from the Portage Creek Corridor Reuse Plan (The Corradino Group of Michigan 2009) is included as Attachment 3 for informational purposes.

1.7 Identification of Constituents of Concern

The RI Report (MDEQ 2008) included a comparison of all detected chemical constituent concentrations of Target Compound List (TCL) volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, PCBs, and Target Analyte List (TAL) inorganic constituents in residuals, soil, groundwater, groundwater seeps, sediments, and surface water to Act 451 Part 201 screening criteria. These screening criteria are conservative risk-based values developed by the MDEQ using generic exposure factors and scenarios. The outcome of the comparison of the data to the screening criteria was that PCBs, SVOCs, and inorganic constituents were all classified as potential constituents of concern (COCs) within soil/sediment at the OU, and PCBs and inorganic constituents were identifies as potential COCs in groundwater.

As discussed in Section 1.6, the USEPA evaluated exposure pathways, receptors, and land use scenarios at the Allied OU for consideration in development of PRGs (CH2M Hill 2009). Among USEPA's findings were that the drinking water pathway is considered incomplete at the Allied OU. This finding was further supported by the Supplemental Groundwater Study, as described in Section 1.5.

For the purposes of this FS, MHLLC conducted an updated comparison of the RI data to the USEPA PRGs (discussed in Section 1.7) and to Michigan Act 451 Part 201 screening criteria. This re-evaluation of the data was necessary for the following reasons:

- The RI Report included a screening of soil, residuals, groundwater, and groundwater seep data against Michigan Act 451 Part 201 screening criteria intended to be protective of drinking water. In this FS screening evaluation, criteria developed for the protection of drinking water were not used because this exposure pathway is considered incomplete.

- In 1999, the USEPA issued a Certificate of Completion for the TCRA. Pursuant to the cashout agreement with Millennium Holdings, Inc. (predecessor to MHLLC), the USEPA agreed that MHLLC would not be required to undertake further action in the Former Bryant Mill Pond Area (USEPA 1998).

- MHLLC undertook an IRM to remove PCB-containing soils and residuals from areas within the Portage Creek floodplain using the same target cleanup goals, removal methods, and restoration procedures used by USEPA. These areas were excluded from consideration for further remediation as part of the FS.

- Historical surface soil samples that are now covered with the impermeable cap in the Bryant HRDL/FRDLs disposal area were considered to be subsurface samples in the FS screening evaluation.

- Where available, updated Act 451 Part 201 screening criteria were used in the FS screening evaluation.

Tabular summaries of the screening evaluations for samples of soils, sediments, groundwater, and seeps at the Allied OU are presented in Attachment 4 for PCB data, and in Attachment 5 for TCL VOCs, SVOCs, and TAL inorganic constituents. The locations where sample analytical results are above the screening criteria are summarized graphically on a series of figures in Attachments 4 and 5 – these figures are modified from those that were included with the RI Report. The results of the data screening evaluation are discussed in the following sections.

1.7.1 Focus on PCBs

The investigation and cleanup work at the OU over the past decade has consistently been driven by the presence of PCBs and focused on mitigating potential risks posed by PCBs. For the purposes of the FS analyses, PCBs are a COC in soils, sediment, and residuals. As described in Section 1.1 of the RI Report (MDEQ 2008), although constituents other than PCBs have been detected in various media, “Early investigative efforts recognized that if the full extent of polychlorinated biphenyls (PCBs) was identified and appropriately remediated, then other associated hazardous substances at this or any other OU would be appropriately addressed.”

Tables A4-1 through A4-5 in Attachment 4 present a data screening summary of the sampling locations in which PRGs are exceeded for PCBs in:

- samples of soil, residuals, and sediment collected during the RI

- groundwater and seep samples collected during the most recent (2002/2003) comprehensive sampling activity, which is most representative of current conditions

Figures A4-1 through A4-6 in Attachment 4 are maps taken from the RI Report (MDEQ 2008) that depict locations in which PRGs are exceeded for PCBs in soils, residuals, sediments, groundwater, and groundwater seep samples. PCBs are prevalent in soils and residuals throughout the Allied OU at concentrations above PRGs, and are identified as a COC in these media. PCBs are also found in sediment samples in certain locations at concentrations that exceed PRGs, and are identified as a COC in sediments. In the most recent comprehensive groundwater sampling activity (2002/2003), PCBs were detected at concentrations above the PRGs established by USEPA in groundwater samples collected from only 3 of 57 monitoring well locations and only 2 of 20 seep locations (see Tables A4-4 and A4-5 and Figures A4-5 and A4-6 in Attachment 4).

The three groundwater sampling locations at which the PRG for PCBs in groundwater was exceeded are MW-8A and FW-101 in the Western Disposal Area, and MW-122AR in the Bryant HRDL/FRDLs area. Monitoring well MW-8A is a single-cased well that was constructed with the filter pack within saturated residuals The FW-101 well was installed with the screen placed within fill material that was known to contain PCBs, as confirmed by sampling, and was therefore identified as “Fill Well” FW-101. The cap over the Bryant HRDL/FRDLs had not been completed at the time of the 2002/2003 sampling effort, making the MW-122AR sampling location vulnerable to influx of PCBs from surface water held in the adjacent unlined settling basin.

The two seep locations in which the groundwater PRG for PCBs was exceeded are SP-G and SP-H in the Former Type III Landfill. These seeps are located a few feet from each other, along the interface of where the unremediated Type III landfill meets the remediated Former Bryant Mill Pond, and may originate from the same groundwater discharge location.

Most importantly, none of the sampled locations where PCBs were detected at concentrations above the relevant PRGs had been addressed by an IRM at the time of the sampling event. Based on the limited number of sampling locations where PCBs were detected in samples of groundwater and seeps at concentrations above PRGs, and the apparent inability for the PCB-containing materials to serve as a significant source of contamination to groundwater that discharges to Portage Creek, PCBs are not identified as a COC in groundwater. The presence of PCBs in groundwater is discussed further in Section 1.8.

1.7.2 Organic and Inorganic Constituents

Tables A5-1 through A5-8 in Attachment 5 summarize the sampling locations in which MDEQ Act 451 Part 201 generic screening criteria are exceeded for VOCs, SVOCs, and inorganic constituents. For the data screening evaluation, the analytical results for groundwater and seep samples were compared to GSI criteria, and the analytical results for samples of soil and residuals were compared to GSI Protection criteria. The GSI criteria were developed by the MDEQ as the maximum acceptable concentration in groundwater that is considered protective of human health and the environment. The GSI Protection criteria were developed by the MDEQ as the maximum acceptable concentrations in soil that are considered to be protective of groundwater. Figures A5-1 through A5-14 are maps of the locations in which criteria are exceeded for VOCs, SVOCs, and inorganic constituents in samples of these same media.

The VOC carbon tetrachloride was detected in one soil sample at a concentration that exceeded the GSI Protection screening criterion. Based on the data screening evaluation in Attachment 5, VOCs are not identified as COCs in any medium due to their infrequent detection above screening criteria.

The SVOC 4-methylphenol is found in several subsurface residuals samples at concentrations exceeding GSI Protection soil criteria, consistent with the findings of the RI Report. However, since 4-methylphenol was not actually detected in any groundwater sample locations at concentrations exceeding GSI criteria, this SVOC is not identified as a COC in soil.

Similarly, the inorganic constituents cobalt, cyanide, manganese, mercury, selenium, and zinc were detected in several samples of subsurface soils and residuals at concentrations that exceeded GSI Protection soil criteria. However, of these inorganic constituents, only cyanide, manganese and zinc were detected at concentrations exceeding GSI criteria in groundwater or seep samples.

- Cyanide was detected above the GSI criterion in only 3 of 57 groundwater sampling locations (MW-16B, MW-220, and MW-221R) and in 1 of 20 seep locations (SP-N), all located within or downgradient of the Former Type III Landfill.

- Concentrations of selenium did not exceed the GSI criterion at any groundwater sampling locations, and in only 1 of 20 seep locations (SP-611), located in the Western Disposal Area.

- The elevated concentrations of zinc detected in certain groundwater samples are related to well construction materials. Consistent with the findings of the RI Report (MDEQ 2008), zinc was detected at concentrations exceeding GSI criteria in samples of groundwater collected exclusively from pre-RI monitoring wells constructed with galvanized steel pipe risers. Conversely, none of the groundwater samples collected from monitoring wells constructed with stainless steel risers contained zinc at concentrations above GSI criteria. A review of the scientific literature indicates that zinc, iron, manganese, and cadmium are typical products of galvanized steel corrosion (Barcelona 1983, USEPA 1992). Based on the data screening evaluation, zinc is not identified as a COC for any medium at the OU.

Based on the minimal number of locations in which they were detected above GSI in groundwater and seeps samples, no inorganic constituents are identified as COCs in soil, residuals, groundwater, or seeps.

1.8 Groundwater Extraction and Treatment as an Interim Response Measure

In 1999, prior to undertaking the IRM to construct a sheetpile and cap on the Bryant HRDL/FRDLs, MHLLC agreed to a request by MDEQ to install and operate a groundwater extraction system inside the sheetpile and beneath the cap as an additional component of the IRM. The purpose of the system was to mitigate groundwater mounding behind the sheetpile which, in turn, might inundate otherwise unsaturated residuals and increase the potential for migration of PCBs to the creek. MHLLC installed the system as a precautionary measure at MDEQ's request even though no data had been collected to that point that demonstrated a need to treat groundwater for PCBs.

The extraction and treatment system has been in operation since that time, and to date, 43 samples of influent to the system have been collected and sampled for PCBs. PCBs have only been detected in one of these influent samples at the analytical reporting limit of 0.01 μg/L, well below the groundwater PRG of 0.02 μg/L.

As discussed in Section 1.6.1 (Focus on PCBs), in the most recent groundwater sampling activity, PCBs were only detected at concentrations above USEPA PRGs in groundwater samples collected from 3 of 57 monitoring well locations and 2 of 20 groundwater seep locations. Based on these results, it is apparent that PCBs are not widely found at elevated concentrations in groundwater at the Allied OU, even in areas that have not been graded or capped (see Attachment 4, Figures A4-5 and A4-6). The groundwater sampling locations where PCBs were measured at concentrations that exceeded the USEPA PRG are notably in areas of the OU that were not addressed by the installation of an impermeable cap as of the time of sampling in 2002/2003.

Based upon the paucity of PCB detections in samples of groundwater, groundwater seeps, and groundwater collected by the extraction system, the continued need for operation of the system is questionable. It is possible that the actions of grading and capping the materials in the Bryant HRDL/FRDLs have sufficiently reduced the infiltration of water through the residuals to the extent that groundwater extraction to address the potential for PCB migration in groundwater is not necessary.

It has therefore been assumed for the purposes of this assessment that although groundwater monitoring will be a component of the selected remedy at the Allied OU, groundwater extraction and treatment may be retained as a contingent remedy only if monitoring data indicate that other technologies have not adequately met groundwater RAOs. This approach is described in Section 4.7.

2. Development of ARARs and Remedial Action Objectives

This section identifies the areas of the OU considered in this FS Report for remedial action, a list of ARARs, and the applicable RAOs and GRAs.

2.1 Comparison of PCB Data to PRGs

To select which media and what areas of the Allied OU may need to be addressed to manage the potential risks to humans and ecological receptors, the PCB data representative of current conditions were compared to the PRGs developed by USEPA (CH2M Hill 2009) as described in Section 1.7. The results of this PCB assessment are summarized in Attachment 4.

For the purposes of this FS Report, the sub-areas of the OU described in Section 1.2 were evaluated based on the media present (e.g., soil or sediment) and, as appropriate, current land use and zoning (e.g., residential, commercial, or industrial). On Figure 2-1, the areas where PRGs are not currently being achieved are depicted, classified according to PRGs and land use. As described in Sections 1.3.1 and 1.3.2, in three areas – the Former Bryant Mill Pond, the East Bank, and the Former Filter Plant – no additional cleanup action will be necessary because removal actions have already been completed and the PRGs have already been achieved, as verified by confirmation sampling. In addition, the cashout agreement between USEPA and Millennium Holdings, Inc. (USEPA 1998) indicates that no further remedial action is required of MHLLC within the Former Bryant Mill Pond Area, which includes the Clay Seam area. No further actions will be considered in this FS Report for these areas.

The volume of residuals, soils, or sediments that are present at the OU with PCB concentrations above the relevant PRGs was estimated for each sub-area. During the RI work, soil borings were sampled to characterize the vertical and horizontal extent of PCBs within the Allied OU and adjacent areas. These data were used in conjunction with field observations of extent and thickness of “gray clay” material and analytical data to develop the estimated volumes of soils, residuals, and sediments in various areas of the OU where PCBs are present at concentrations above the PRGs (Table 2-1). Note that the volumes presented in the table below are not targeted removal volumes – removal volume estimates are developed for specific remedial alternatives presented in Section 4.

Table 2-1
Media of Concern, Land Use/Zoning Classification, and Estimated Volumes of PCB-Containing Soils and Sediments

Sub-Area	Media of Concern	Land Use/ Zoning	Estimated Volume (cy)[1]	Estimated Area (acres)[1]
Former Operational Areas				
Monarch				
• HRDL Disposal Area[2]	Soils/Groundwater	Industrial	170,000	6.8
• Former Raceway Channel	Sediments		<100	<0.1
Former Type III Landfill[3]	Soils/Groundwater	Industrial	405,000	13.6
Western Disposal Area				
• Disposal Area[4]	Soils/Groundwater		270,000	13.2
• Panelyte Property (southern end)	Soils	Industrial	4,000	1.4
• Panelyte Marsh	Sediments		300	0.9
• Conrail Property	Soils		<100	0.1
Bryant HRDL/FRDLs[5]	Soils/Groundwater	Industrial	635,000	22.1
Residential and Commercial Properties[6]				
Residential Area				
• Golden Age Retirement Community	Soils	Residential	1,100	<0.1
• Single-Family Residences		Residential	2,100	0.3
• MHLLC-owned property		Industrial	7,700	1.1
Commercial Properties				
• Goodwill lawn			28,500	1.7
• Goodwill parking lots			38,500	2.3
• Goodwill beneath buildings	Soils	Commercial	8,500	0.5
• Consumers Power			1,100	<0.1
• MHLLC's Alcott Street Parking Lot			12,000	0.7

Notes (below and on next page):
1. All estimated volumes and areas are approximate. All areas and volumes are based on known or suspected presence of PCBs at any concentration.
2. Monarch HRDL: The estimated area represents the total area of PCB-containing soils. Of these 6.8 acres, it is estimated that approximately 6 acres (135,000 cy) would be capped under a containment scenario, and that approximately 0.8 acre (35,000 cy) would comprise the remaining peripheral area.

3. Former Type III Landfill: The estimated area represents the total area of PCB-containing soils. Of these 13.6 acres, it is estimated that approximately 10 acres (approximately 245,000 cy) would be capped under a containment scenario, and that approximately 3.6 acres (approximately 160,000 cy) would comprise the peripheral area.
4. Western Disposal Area: The estimated area represents the total area of PCB-containing soils. Of these 13.2 acres, it is estimated that approximately 12 acres (245,000 cy) would be capped under a containment scenario, and that approximately 1.2 acres (25,000 cy) would comprise the peripheral area.
5. Bryant HRDL/FRDLs: The estimated volume associated with the Bryant HRDL/FRDLs represents the volume of PCB-containing soil, not the total volume of soil. The total volume of soil associated with this area is approximately 725,000 cy, which includes approximately 90,000 cy of clean soil cover.
6. The volumes of PCB-containing soils within the Residential and Commercial Properties may be further refined based on additional delineation activities.

2.2 Identification and Rationale for ARARs

Section 121(d) of CERCLA requires that Superfund remedial actions attain legally applicable or relevant and appropriate federal and state (to the extent that they are more stringent) requirements, standards, criteria, and limitations which are collectively referred to as ARARs, unless such ARARs are waived under CERCLA Section 121(d)(4). Applicable requirements are those cleanup standards and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a Superfund site. Relevant and appropriate requirements are those cleanup standards and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not applicable, address problems or situations sufficiently similar to those encountered at the Superfund site that their use is well suited to the particular site.

In addition to ARARs, federal or state guidance materials that have not been promulgated, local ordinances or requirements, and regulatory standards that are not applicable or relevant and appropriate may be considered (including local/county requirements); these are referred to as items "to be considered" (TBC). While TBCs may be considered along with ARARs, they do not have the status of ARARs. A complete list of ARARs and TBCs identified for the Allied OU is presented in Table 2-2. These ARARs are based on the USEPA-approved Preliminary List of Possible ARARs included in the *Multi-Area Feasibility Study Technical Memorandum: Preliminary List of Possible Applicable or Relevant and Appropriate Requirements* (ARARs Tech Memo; ARCADIS 2009a). The ARARs Tech Memo was approved by USEPA on December 23, 2008.

2.3 Remedial Action Objectives

In accordance with USEPA guidance (USEPA 1988), RAOs consist of medium-specific or OU-specific goals for protecting human health and the environment. They are based on the exposure pathways that need to be addressed as determined from results of the RI and evaluation of potential risks to human and ecological receptors. In accordance with USEPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (1988) these RAOs were developed considering the relevant media of interest and exposure pathways at the Allied OU. The RAOs are presented in Table 2-3, below.

Table 2-3
Remedial Action Objectives

RAO 1	Mitigate the potential for human and ecological exposure to materials at the Allied OU containing PCB concentrations that exceed applicable risk-based cleanup criteria.
RAO 2	Mitigate the potential for PCB-containing materials to migrate, via erosion or surface water runoff, into Portage Creek or onto adjacent properties.
RAO 3	Facilitate the reliable restriction of groundwater use at the Allied OU, and mitigate the potential for groundwater with PCB concentrations exceeding applicable criteria to migrate to Portage Creek or offsite.
RAO 4	Mitigate the potential for adverse effects to human health and the environment due to implementation of a remedial action.

2.4 General Response Actions

GRAs were identified based upon review and consideration of action-specific ARARs and remedial actions used, or considered for use, at similar sites. GRAs do not explicitly identify specific processes or materials to be used, but rather generic technology types that could be used individually or in combination. The following GRAs can be applied to the RAOs for soils, sediment, and groundwater at the Allied OU:

A. *No Action* – under this approach, no further remedial actions would be undertaken at the OU – monitoring and maintenance activities would also cease.
B. *Institutional Controls* – legal and/or administrative controls that help to minimize the potential for human or ecological exposure to contamination and protect the integrity of the remedy.

C. *Monitoring* – includes monitoring of groundwater and landfill gas, as well as physical structures for the purpose of identifying non-compliance.
D. *Monitored Natural Attenuation* – includes those natural processes that reduce the bioavailability of PCBs over time and monitoring to gauge the performance of those processes against expectations.
E. *In-Situ Containment* – includes onsite consolidation of soils/sediments in an engineered disposal area at the OU; application of hazardous waste landfill (i.e., fully encapsulating) containment; erosion controls; and hydraulic modifications.
F. *In-Situ Treatment* – considers the in-place treatment of soil and sediment to remove or destroy PCBs.
G. *Removal* – considers soil and sediment excavation.
H. *Ex-Situ Treatment* – includes:
    - the use of water treatment technologies (e.g., activated carbon) to reduce the volume, mobility, and toxicity of PCBs in water.
    - the treatment of soil and/or sediment by a permitted treatment facility to reduce the volume, mobility, and toxicity of PCBs.
I. *Transportation and Disposal* – considers offsite transportation of soil and sediment to an appropriately permitted landfill facility for disposal; and consolidation of materials excavated from offsite areas into in an onsite area designated as a landfill. For the offsite disposal option, the type of facility would be selected based on the PCB concentrations in the materials to be disposed. Materials with PCB concentrations equal to or above 50 mg/kg are required to be disposed in a Toxic Substances Control Act (TSCA) regulated landfill, while materials with PCB concentrations below 50 mg/kg are disposed in solid waste landfills.

3. Identification and Evaluation of Technologies

To achieve the RAOs established for the Allied OU, a range of remedial technologies and process options were identified and evaluated, then potentially applicable approaches were used to develop a set of remedial alternatives. Based on USEPA guidance (1988), potentially applicable remedial technologies are evaluated in two steps. First, a wide array of possible remedial technologies is evaluated based on the potential for technical implementability at the OU given the data gathered throughout the RI on PCBs, media of concern, and characteristics of the OU. Technologies that cannot be feasibly implemented are eliminated. Next, the remedial technologies that have not been eliminated are further evaluated based on overall effectiveness, implementability, and relative cost. Representative technologies retained following this screening step then are assembled into a range of potential remedial alternatives. This process is described in this section of the FS Report.

3.1 Identification and Screening of Remedial Technologies

Based on the OU-specific GRAs defined in Section 2.4, a wide variety of potential technology types and process options associated with each GRA were compiled. "Remedial technologies" are considered as general categories of technologies, while "process options" refer to specific processes within each technology type (USEPA 1988). For example, erosion control is a remedial technology under the more general in-situ containment GRA, and installation of a sheetpile wall is a process option under erosion control. As noted above, remedial technologies and process options are first evaluated only on the basis of technical implementability at the OU. In this step, the evaluation of technical implementability is a general, non-detailed consideration of whether a remedial technology or process option is applicable with respect to specific OU conditions, whether implementation is feasible, and whether the technology has been fully developed for use. This analysis is based on information from a variety of sources, including general knowledge and experience at the Allied OU and the Superfund Site, experience gained from other similar sites, scientific literature, and published reports, such as pertinent USEPA documents. Consistent with USEPA guidance (USEPA 1988), this initial screening step is conducted to reduce the number of potential remedial technologies that will undergo a more rigorous evaluation. Process options and entire technology types can be eliminated from further consideration on the basis of technical implementability (USEPA 1988). In this manner, only those technologies that could be effectively implemented at the specific site in question are carried forward to the next step.

Table 3-1 summarizes the identification and screening of potential remedial technologies and process options that could reasonably be applied to soils, sediments, and groundwater that are potentially subject to remediation. The first column of the table identifies GRAs with several broad technology types, and associated process options are provided in the second column. This table also provides a brief description of each process option, the media to which the option may apply, and a preliminary assessment of technical implementability. Process options that are shaded in Table 3-1 did not meet the technical implementability criteria as described above and, therefore, were not retained for further evaluation.

In some cases, only one representative process option was carried forward for further evaluation (see bolded options in Table 3-1). The selection of a representative process option is not intended to eliminate other retained process options in a technology type from possible use – it is simply intended to streamline the development of potential remedial alternatives. A process option not selected as representative could still be considered during remedial design if its technology type were part of the selected remedial alternative.

This approach is provided for in USEPA guidance (1988), where it states: “One representative process is selected, if possible, for each technology type to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design. The representative process provides a basis for developing performance specifications during preliminary design; however, the specific process actually used to implement the remedial action at a site may not be selected until the remedial design phase.”

For example, in the transportation remedial technology, while both rail and truck transport are feasible approaches, only truck transport was retained as the representative process option and carried through for further analysis. While rail transport is theoretically possible, the issues associated with hauling materials to and from the OU via rail are significantly more complex than transport via truck. Logistical issues associated with rail transport include, but are not limited to: time and expense to construct a railroad spur for alternatives in which a moderate volume (e.g., less than 200,000 cy) of PCB material is to be shipped for offsite disposal, or construction of a rail yard consisting of several spurs for larger scale removal operations; potential difficulties finding a solid waste landfill facility that is also located on a train line; the requirement to offload from rail to truck service at the location of a TSCA facility; the likely need to transfer between railroads lines owned by different parties to reach a disposal destination; and limits as to the number of railcars that can be shipped at one time given railroad crossing restrictions. At this stage of remedy development, there is no compelling reason to examine rail transport since truck transport has been the remedial technology of choice for every other cleanup project associated with the Superfund Site to date.

3.2 Evaluation of Process Options

The next step of the assembly and screening of remedial technologies is to further evaluate the remedial process options retained at the end of the first step (i.e., those options *not* shaded in Table 3-1) based on the expanded criteria of overall effectiveness (ability to meet RAOs, implementation effects, and reliability), implementability (technical and administrative), and relative cost (USEPA 1988).

Consistent with USEPA guidance (1988), the criteria for the secondary screening included effectiveness, implementability, and cost as described below.

Effectiveness – Potential effectiveness is evaluated with respect to the expected ability of the process option to mitigate potential risks to human health and the environment and achieve the RAOs. Potential impacts during construction and implementation are also considered along with reliability of the technology. Knowledge of the effectiveness of these process options at other relevant environmental cleanup sites and previous experience with activities addressing soils and sediments at other OUs within the Kalamazoo River Superfund Site were also considered in evaluating effectiveness.

Implementability – The evaluation of implementability encompasses both the technical and administrative feasibility of incorporating the process option into the remedy. Since technical implementability is the primary focus of the first step in the screening process (described in Section 3.1), in this second step there is a greater emphasis on the administrative aspects, including the availability of specific materials and equipment and appropriately trained workers; and the issues associated with securing necessary approvals and meeting substantive requirements of permits. Technical issues such as the ability to construct, reliably operate, and meet technical specifications or criteria relevant to each technology or process option are also considered along with the operation and maintenance (O&M) required in the future, following remedy implementation.

Cost – The overall relative cost of implementing each remedial technology or process option is identified so that a comparative evaluation of process options within each remedial technology type can be made. As a screening tool, relative capital and O&M costs are considered. For each remedial technology and associated process options, relative costs are generally presented as low, moderate, or high.

The results of the second phase of screening potential remedial technologies and process options in terms of effectiveness, implementability, and cost are presented in Table 3-2. Based on the two-step evaluation and technology screening process, representative process options for each technology type were retained for incorporation into the range of potential remedial alternatives. Consistent with state and federal guidance, the No Further Action GRA was kept for use as a baseline against which other remedial alternatives will be evaluated.

Process options were eliminated during this second screening step if they were determined to be ineffective in meeting the RAOs established in Section 2.3; not applicable to PCBs, conditions at the OU, or the media of concern; not sufficiently demonstrated at pilot scale or full scale; or if they were similar to other retained options but had a much higher relative cost to implement. The specific process options eliminated at this stage are shaded on Table 3-2, and the rationale for elimination is presented. Each process option eliminated is listed below along with a brief description of the reason for excluding it from further consideration (see the table for more detail).

- *Engineered Barrier – Hazardous Waste Landfill Containment System*: Not retained based on short-term effectiveness (potential for direct exposure and potential for release/migration during construction is significant), implementability (space limitations for stockpiling removed materials, limited capacity for final placement of targeted materials), and cost. (As described in Section 3-3, although this process option was screened out at this phase, it was included in the assembly of remedial alternatives to satisfy a specific request from the USEPA.)

- *Ex-Situ Treatment – Basic Extractive Sludge Treatment*: Not retained based on short-term effectiveness (potential risks to human health and the environment during implementation), proven applicability (treatability study would be necessary since this approach has not been proven effective at treating PCBs in paper-making residuals), and implementability (limitations based on scale of the OU and quantity of PCB-containing materials subject to treatment).

- *Ex-Situ Treatment – Offsite Incineration*: Not retained based on short-term effectiveness (potential risks to human health and the environment during implementation, significant localized air quality impacts), implementability (limitations based on scale of the OU and quantity of PCB-containing materials subject to treatment), and cost.

The process options retained following screening (those that are *not* shaded in Table 3-2) could be applied and assembled in a variety of different ways to develop a range of complete remedial alternatives for the OU. Table 3-3 presents a matrix of the retained remedial technologies that could potentially be a major component of a remedy, and the areas of the OU to which they are potentially applicable. In the sub-areas of the OU where remedial action may be necessary to achieve the RAOs, more than one viable approach might exist, and the matrix was used to guide the process of assembling an appropriate array of potential remedial alternatives.

3.3 Assembly of Alternatives

The array of alternatives assembled from the retained process options are listed below. Each of these alternatives is described in detail in Section 4, then evaluated with respect to the relevant CERCLA criteria in Sections 5 and 6.

- Alternative 1 – No Further Action
- Alternative 2 – In-Place Containment/Consolidation of Outlying Areas[2], Onsite Consolidation/Containment beneath an Earthen Cover, Institutional Controls
- Alternative 3 – In-Place Containment/Consolidation of Outlying Areas, Onsite Consolidation/Containment beneath an Impermeable Barrier, Institutional Controls
- Alternative 4 – Removal and Offsite Disposal, Onsite Consolidation/Containment of Former Operational Areas beneath an Impermeable Barrier, Institutional Controls
- Alternative 5 – Total Removal and Offsite Disposal (with or without Immobilization), Sheetpile Removal, Institutional Controls
- Alternative 6 – Hazardous Waste Landfill Containment, Sheetpile Removal, Institutional Controls

As described in Section 3.2, the hazardous waste landfill containment system process option represented in Alternative 6 was eliminated during the screening process due to the significant issues with short-term effectiveness, implementability, and relative cost. In addition, implementing this process option would take significantly longer than the other more feasible approaches, and the extra time, effort, and cost would not provide any measurable degree of improved long-term effectiveness. Nevertheless, the USEPA requested that this approach be retained for detailed evaluation based upon input received at a public meeting held on September 10, 2009. This request from the USEPA was based on concern of community

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[2] Outlying Areas are those sub-areas that are not located within the boundary of the Allied OU. These outlying areas include the Residential Area (consisting of the single family residences and the MHLLC-owned adjacent property), and the Commercial Properties (Goodwill, Consumers Power, and MHLLC's Alcott Street parking lot). For the purposes of the FS analysis, the Goodwill property is considered in three portions – the lawn area, the areas underneath parking lots, and the area underneath building structures.

members that groundwater at the Allied OU might migrate to the City's drinking water wells at some point in the future; however, as summarized in Section 1.5 and described in Attachment 1, the findings of the recently-completed Supplemental Groundwater Study confirmed that the presence of a laterally extensive aquitard along with an upward vertical hydraulic gradient between the regional aquifer (used by the City for potable purposes) and the shallow aquifer, make the potential for migration of groundwater from the Allied OU to the City's Central Well Field unlikely.

In addition to the fully assembled alternatives, a Contingent Groundwater Remedy, which could be a component of any alternative in which PCB-containing materials are left in place, is described in conceptual terms in Section 4.7. As requested by USEPA, approaches for removing the sheetpile wall currently in place along the western bank of Portage Creek are presented in Section 4.8, along with a discussion of long-term O&M considerations for retaining the sheetpile in place.

4. Array of Potential Remedial Alternatives

Based on the results of the screening steps described in Section 3, the specific technologies and process options retained were assembled into a series of potential remedial alternatives that could be implemented to achieve the RAOs established for the Allied OU.

The range of alternatives presented here was developed considering USEPA guidance (1988), which states that alternatives with the “most favorable composite evaluation of all factors [i.e., effectiveness, implementability, and cost] should be retained for further consideration during the detailed analysis.” The USEPA guidance also states that the alternatives developed should “provide decision-makers with an appropriate range of options” and “form alternatives for the site as a whole.” To the extent possible, the alternatives should represent “distinct viable options.”

The potential remedial alternatives for the Allied OU – which range from No Further Action to targeted removal and onsite containment to the complete removal and offsite disposal of all PCB-containing materials – are described in this section.

Common Elements of Alternatives

For all alternatives except Alternative 1 (No Further Action), pre-design investigations would be conducted to further delineate the nature and extent of the presence of PCBs at concentrations above the relevant PRGs. Additional sampling will likely be necessary at the Panelyte Marsh and Panelyte Property as well as in the outlying areas – specifically the portions of the lawn area on the Goodwill property, beneath the parking lots on the Goodwill property, Consumers Power property, the Golden Age Retirement Community, the single-family residential properties, and the adjacent MHLLC property. In addition, it is anticipated that soil borings would need to be advanced to understand the thickness of fill materials overlying the layer of soil containing PCBs at the Alcott Street parking lot, the lawn area on the Goodwill property, the Consumers Power property, the single-family residential properties, and the adjacent MHLLC property to confirm the adequacy of the existing fill layer to serve as a barrier to prevent direct exposure to PCB-containing materials. The results of the pre-design work would be used to determine the most appropriate remedial response for these areas. Details of the pre-design work would be developed and submitted to USEPA for approval once a final remedy is selected.

Similarly, all alternatives other than Alternative 1 include some form of institutional controls (e.g., deed restrictions, access restrictions), and incorporate a groundwater monitoring program as part of a remedy that would include periodic sampling of sentinel wells according to a plan approved by USEPA. If confirmed monitoring results indicate that PCBs are migrating offsite in groundwater at concentrations that require action, a contingent groundwater remedy may be required. If such an action is necessary, MHLLC would develop the plan in consultation with the USEPA at that time. The proposed contingent groundwater remedy is described in Section 4.7.

The 2,600 linear feet of sealed-joint sheetpile installed in 2001 along the western bank of Portage Creek to stabilize the perimeter berms of the Bryant HRDL and FRDLs is expected to be maintained in place for all alternatives except Alternatives 5 and 6. However, USEPA requested that sheetpile removal be considered in the development of alternatives. Sheetpile removal has been evaluated as a potential "add on" component of Alternatives 2, 3, and 4 – in these alternatives, the Bryant HRDL/FRDLs would be managed in place beneath the existing engineered landfill cap. Section 4.8 includes a discussion of USEPA's request, a description of two potential approaches to sheetpile removal, and estimated costs.

As described in detail in Sections 1.3.2 and 2.1, as a result of data review and the work already completed in the Former Bryant Mill Pond Area, the East Bank, the Former Filter Plant area, and the Clay Seam, cleanup goals have already been satisfied in these locations. These areas are not included in the development of alternatives.

The alternatives and their applicability to different sub-areas of the OU are described below.

4.1 Alternative 1 – No Further Action

The No Further Action alternative is required to be included in the FS under the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and serves as a baseline against which the other potential remedial alternatives can be compared.

<u>Description of Alternative</u>

No further active remediation would be performed in any area of the OU. Natural attenuation processes would continue, but would not be monitored to gauge progress toward the RAOs. The potential for human and ecological receptors to be exposed to PCBs would not be addressed, and there would remain a potential for PCBs to erode into Portage Creek over time since there would be no maintenance of the existing fence, cap, soil cover, other engineered control systems, or the Alcott Street Dam. Operation of the groundwater collection/treatment system would be discontinued. This alternative is depicted on Figure 4-1.

4.2 Alternative 2 – In-Place Containment/Consolidation of Outlying Areas, Onsite Consolidation/Containment beneath an Earthen Cover, Institutional Controls

In Alternative 2, the primary element of the remedy is in-place containment. Two sub-alternatives (described in Section 4.2.1 and 4.2.2) were developed to present different approaches for addressing certain offsite outlying areas of the OU. In Alternative 2A, certain offsite outlying areas are targeted for in-place containment under an earthen cover, while in Alternative 2B those areas would be consolidated into one of the existing uncapped onsite disposal areas (Western Disposal Area, Type III Landfill, and/or Monarch HRDL). These onsite disposal/consolidation areas would then be contained under an earthen cover. The earthen covers would consist of the following layers, from bottom to top:

- 6-inch thick soil grading layer (select fill)
- non-woven geotextile separation layer
- 1-foot thick soil protection/drainage layer (sand)
- 6-inch thick topsoil layer

The topsoil would be seeded and mulched to promote the development of appropriate vegetation.

In the outlying areas where there are either structures or clean fill that serve to mitigate direct contact and limit mobility of PCB-containing materials (i.e., Alcott Street Parking Lot, and the Goodwill building and parking lots) and the concentrations of PCBs (if present) in these locations are below the relevant PRGs, institutional controls will be employed to prevent actions that might compromise existing conditions.

In outlying areas where structures or fill are not present to serve as a barrier to exposure (i.e., portions of Goodwill lawn area, Consumers Power, Golden Age Retirement Community, the single-family residential properties, and the adjacent MHLLC property), PCB-containing materials would either be contained in-place under an earthen cover (Alternative 2A – see Section 4.2.1) or excavated and consolidated under the earthen cover installed onsite (Alternative 2B – see Section 4.2.2). However, active cleanup work may not be necessary. If pre-design sampling confirms that the thickness of the overlying clean fill in these areas is sufficient to mitigate direct contact, institutional controls such as deed restrictions, permit tools, and informational devices will be employed in lieu of a containment or excavation/consolidation approach to prevent actions that might compromise existing conditions.

As a conservative measure, those areas of the Monarch HRDL, Type III Landfill, and Western Disposal Area where PCB-containing materials lie close to Portage Creek will be excavated/pulled back and consolidated within the uncapped onsite disposal areas to create an adequate setback or protective buffer along the creek. The existing sheetpile wall along Portage Creek would be left in place, and no consolidation/excavation would be necessary behind the wall. See Section 4.8 for a description of an alternate approach involving removal of the sheetpile.

Similarly, PCB-containing materials located along the outside property lines of the uncapped onsite disposal areas (e.g., Western Disposal Areas, areas of the Panelyte Marsh, Panelyte Property, and Conrail Property) would be excavated and consolidated into the uncapped onsite disposal areas to create a setback from adjacent properties. PCB-containing sediments in the Former Monarch Raceway Channel would also be consolidated in the Monarch HRDL. The PCB-containing materials consolidated into the uncapped onsite disposal areas would be graded to a stable repose, then the areas would be covered with an earthen cover. The earthen cover would be constructed with appropriate erosion controls and other measures to protect against events or incidents that might otherwise threaten the integrity of the disposal areas. The existing impermeable engineered landfill cap over the Bryant HRDL/FRDLs would be maintained in place, as would the sheetpile wall along the western bank of Portage Creek.

Post-removal confirmatory sampling and analysis would be performed at the excavation areas. Once cleanup goals have been achieved, the excavated areas would be backfilled with clean material, graded to mitigate ponding, and revegetated. The Panelyte Marsh and Former Monarch Raceway Channel would be backfilled to existing grades and restored to promote the re-establishment of native vegetation.

Both Alternative 2A and Alternative 2B would include long-term inspections and maintenance of the Alcott Street Dam, the newly installed earthen covers, the existing impermeable engineered landfill cap, and the existing sheetpile. In addition, a long-term monitoring program would be implemented to verify that groundwater quality conforms to applicable risk-based standards and to provide for the appropriate management of landfill gas.

Institutional controls (e.g., deed restrictions to prevent exposure of PCBs at depth, enforcement tools to facilitate the long-term O&M of the dam, perimeter fence with posted warning signs, permit tools, informational devices) would be implemented at outlying areas and the onsite disposal areas to prevent actions that might result in direct contact with PCB-containing materials.

Alternatives 2A and 2B are described below.

4.2.1 Alternative 2A – Containment of Outlying Areas and Onsite Former Operational Areas beneath Earthen Covers, Groundwater and Landfill Gas Monitoring, and Institutional Controls

Description of Alternative

Under Alternative 2A, after excavating the targeted PCB-containing materials that lie close to Portage Creek; in the Panelyte Marsh, Panelyte Property, and Conrail Property; and along the outside property lines of the Former Operational Areas (an estimated total of 225,000 cy) and consolidating them into the Monarch HRDL, Type III Landfill, and Western Disposal Area, the following areas would be graded in place and then covered with an earthen cover (see Figure 4-2):

- outlying areas where structures or fill are not present to serve as a barrier to exposure (portions of Goodwill lawn area, Consumers Power, Golden Age Retirement Community, the single-family residential properties, and the adjacent MHLLC property)
- the uncapped onsite disposal areas

These areas cover a total area of approximately 31 acres. The existing impermeable engineered landfill cap over the Bryant HRDL/FRDLs and the existing sheetpile wall would be maintained in place.

4.2.2 Alternative 2B – Consolidation of Selected Outlying Areas, Onsite Consolidation/ Containment of Former Operational Areas beneath an Earthen Cover, Groundwater and Landfill Gas Monitoring, and Institutional Controls

Description of Alternative

Under Alternative 2B, approximately 40,500 cy of soil and/or sediment containing PCBs above the relevant PRGs would be excavated from outlying areas where structures or fill are not present to serve as a barrier to exposure (portions of Goodwill lawn area, Consumers Power, Golden Age Retirement Community, the single-family residential properties, and the adjacent MHLLC property) and consolidated in the uncapped onsite disposal areas (i.e., the Monarch HRDL, Type III Landfill, and Western Disposal Area) (see Figure 4-3).

The PCB-containing materials that lie close to Portage Creek; in the Panelyte Marsh, Panelyte Property, and Conrail Property; and along the outside property lines of the Former Operational Areas (an estimated total of 225,000 cy) would also be consolidated into the uncapped onsite disposal areas along with PCB-containing sediments in the Former Monarch Raceway Channel.

The excavated areas would be backfilled with clean material, graded, and revegetated to match the surrounding area.

The onsite disposal areas would be graded and then contained beneath an earthen cover (covering an area of approximately 28 acres). The existing impermeable engineered landfill cap over the Bryant HRDL/FRDLs and the existing sheetpile wall would be maintained in place.

4.3 Alternative 3 – In-Place Containment/Consolidation of Outlying Areas, Onsite Consolidation/Containment beneath an Impermeable Barrier, Institutional Controls

Alternative 3 is similar to Alternative 2, except the onsite disposal areas that are currently uncapped would be consolidated/contained under an impermeable engineered barrier rather than an earthen cover. Two sub-alternatives (described in Section 4.3.1 and 4.3.2) were developed in which different areas of the OU are targeted for excavation, but all excavated materials would be consolidated onsite.

The impermeable engineered barrier included in this alternative would include the following layers (from bottom to top):

- 6-inch thick soil grading layer (select fill)
- non-woven geotextile separation layer
- 12-inch thick gas venting layer (sand – passive gas vents would be installed into this layer)
- 30-mil PVC liner
- geotextile cushion layer
- 2-foot thick soil protection/drainage layer (sand)
- 6-inch thick topsoil layer

The topsoil would be seeded and mulched to promote the development of appropriate vegetation.

In the outlying areas where there are either structures or clean fill that serve to mitigate direct contact and limit mobility of PCB-containing materials (i.e., Alcott Street Parking Lot, and the Goodwill building and parking lots) and the concentrations of PCBs (if present) in these locations are below the relevant PRGs, institutional controls will be employed to prevent actions that might compromise existing conditions.

The remaining outlying areas are addressed differently in Alternative 3A and 3B. As described in more detail below, certain outlying areas (i.e., portions of Goodwill lawn area, Consumers Power, Golden Age Retirement Community, the single-family residential properties, and the adjacent MHLLC property) will be contained in-place under an earthen cover (Alternative 3A – see Section 4.3.1), or excavated and consolidated under an impermeable engineered barrier installed onsite (Alternative 3B – see Section 4.3.2). However, active cleanup work may not be necessary. If pre-design sampling confirms that the thickness of the overlying clean fill at any of these locations is sufficient to mitigate direct contact, institutional controls such as deed restrictions, permit tools, and informational devices will be employed in lieu of a containment or excavation/consolidation approach to prevent actions that might compromise existing conditions.

As a conservative measure, those areas of the Monarch HRDL, Type III Landfill, and Western Disposal Area where PCB-containing materials lie close to Portage Creek will be excavated/pulled back and consolidated within the uncapped onsite disposal areas to create an adequate setback or protective buffer along the creek. The existing sheetpile wall along Portage Creek would be left in place, and no consolidation/excavation would be necessary behind the wall. See Section 4.8 for a description of an alternate approach involving removal of the sheetpile.

Similarly, PCB-containing materials located along the outside property lines of the uncapped onsite disposal areas (e.g., Western Disposal Areas, areas of the Panelyte Marsh, Panelyte Property, and Conrail Property) would be excavated and consolidated into the uncapped onsite disposal areas to create a setback from adjacent properties. PCB-containing sediments in the Former Monarch Raceway Channel would also be consolidated in the Monarch HRDL. The PCB-containing materials consolidated into the existing uncapped onsite disposal areas would be graded to a stable repose, then the areas would be covered with an impermeable engineered barrier (consistent with Michigan Act 451, Part 115 solid waste landfill cover regulations). The barrier would be constructed with appropriate erosion controls and other measures to protect against events or incidents that might otherwise threaten the integrity of the disposal areas. The existing impermeable engineered landfill cap over the Bryant HRDL/FRDLs would be maintained in place, as would the sheetpile wall along the western bank of Portage Creek.

Post-removal confirmatory sampling and analysis would be performed at the excavation areas. Once cleanup goals have been achieved, the excavated areas would be backfilled with clean material, graded to mitigate ponding, and revegetated. The Panelyte Marsh and Former Monarch Raceway Channel would be backfilled to existing grades and restored to promote the re-establishment of native vegetation.

Both Alternatives 3A and 3B would include long-term inspections and maintenance of the Alcott Street Dam and the new and existing earthen covers and impermeable barriers. In addition, a monitoring program would be implemented to verify that groundwater quality conforms to applicable risk-based standards and to provide for the appropriate management of landfill gas.

Institutional controls (e.g., deed restrictions to prevent exposure of PCBs at depth, enforcement tools to facilitate the long-term O&M of the dam, perimeter fence with posted warning signs, permit tools, informational devices) would be implemented at outlying areas and the onsite disposal areas to prevent actions that might result in direct contact with PCB-containing materials.

Alternatives 3A and 3B are described below.

4.3.1 Alternative 3A – Containment of Selected Outlying Areas beneath an Earthen Cover, Onsite Consolidation/Containment of Former Operational Areas beneath an Impermeable Engineered Barrier, Groundwater and Landfill Gas Monitoring, and Institutional Controls

Description of Alternative

Under Alternative 3A, the outlying areas that will not be addressed using institutional controls will be contained in-place under an earthen cover. These are areas where structures or fill are not present to serve as a barrier to exposure (i.e., portions of Goodwill lawn area, Consumers Power, Golden Age Retirement Community, the single-family residential properties, and the adjacent MHLLC property). The total area is approximately 3 acres (see Figure 4-4). The earthen cover would have the following components (from bottom to top): 6-inch thick soil grading layer (select fill); non-woven geotextile separation layer; 1-foot thick soil protection/drainage layer (sand); and a 6-inch thick topsoil layer. The topsoil would be seeded and mulched to promote the development of appropriate vegetation.

After consolidation of onsite PCB-containing materials that lie close to Portage Creek; in the Panelyte Marsh, Panelyte Property, and Conrail Property; and along the outside property lines of the Former Operational Areas (a total of approximately 225,000 cy), the Monarch HRDL, Type III Landfill, and Western Disposal Area would be contained beneath an impermeable engineered barrier (i.e., designed in accordance with Michigan Act 451, Part 115). The new barrier over these areas would cover approximately 28 acres.

The existing impermeable engineered landfill cap over the Bryant HRDL/FRDLs and the existing sheetpile wall would be maintained in place.

4.3.2 Alternative 3B – Consolidation of Outlying Areas (except where structures present), Onsite Consolidation/Containment of Former Operational Areas beneath an Impermeable Engineered Barrier, Groundwater and Landfill Gas Monitoring, and Institutional Controls

Description of Alternative

Under Alternative 3B, approximately 91,000 cy of soil and/or sediment containing PCBs above the relevant PRGs would be excavated from all offsite outlying areas other than the portion of the Goodwill property covered by buildings (see Figure 4-5). The following areas would be excavated:

- portions of Goodwill lawn area
- Goodwill parking lots
- MHLLC's Alcott Street parking lot
- Consumers Power
- Golden Age Retirement Community
- the single-family residential properties and the adjacent MHLLC property

The excavated areas would be backfilled with clean material, graded, and revegetated to match the surrounding area.

The PCB-containing materials excavated from the offsite outlying areas would be consolidated into onsite disposal areas (along with the approximately 225,000 cy of materials consolidated from the portions of the Monarch HRDL, Type III Landfill, and Western Disposal Area that lie close to Portage Creek; in the Panelyte Marsh, Panelyte Property, and Conrail Property; and along the outside property lines of the Former Operational Areas) and contained beneath an impermeable cap designed in accordance with the requirements of Michigan Act 451, Part 115 solid waste regulations. The new barrier over these areas would cover approximately 28 acres. The existing impermeable engineered landfill cap over the Bryant HRDL/FRDLs and the existing sheetpile wall would be maintained in place.

4.4 Alternative 4 – Removal and Offsite Disposal, Onsite Consolidation/Containment of Former Operational Areas beneath an Impermeable Barrier, Institutional Controls

In Alternative 4, the primary components of the remedy are removal and offsite disposal of the outlying areas[3], and onsite containment under an impermeable engineered barrier.

The impermeable engineered barrier included in this alternative would include the following layers (from bottom to top):

- 6-inch thick soil grading layer (select fill)
- non-woven geotextile separation layer
- 12-inch thick gas venting layer (sand – passive gas vents would be installed into this layer)
- 30-mil PVC liner
- geotextile cushion layer
- 2-foot thick soil protection/drainage layer (sand)
- 6-inch thick topsoil layer

Two sub-alternatives (described in Section 4.4.1 and 4.4.2) were developed in which different areas of the OU are targeted for excavation, but all excavated materials would be disposed of in appropriately permitted offsite solid waste landfills. The excavated areas would be backfilled with clean material, graded, and revegetated to match the surrounding area.

Post-removal confirmatory sampling and analysis would be performed at the excavation areas. Once cleanup goals have been achieved, the excavated areas would be backfilled with clean material, graded to mitigate ponding, and revegetated. The Panelyte Marsh and Former Monarch Raceway Channel would be backfilled to existing grades and restored to promote the re-establishment of native vegetation.

As a conservative measure, those areas of the Monarch HRDL, Type III Landfill, and Western Disposal Area where PCB-containing materials lie close to Portage Creek will be excavated/pulled back and consolidated within the uncapped onsite disposal areas to create an adequate setback or protective buffer along the creek. The existing sheetpile wall along Portage Creek would be left in place, and no consolidation/excavation would be necessary

[3] If pre-design sampling confirms that the thickness of the overlying clean fill at any of the outlying areas is sufficient to mitigate direct contact, institutional controls such as deed restrictions, permit tools, and informational devices will be employed in lieu of a containment or excavation/consolidation approach to prevent actions that might compromise the existing, stable conditions.

behind the wall. See Section 4.8 for a description of an alternate approach involving removal of the sheetpile.

Similarly, PCB-containing materials located along the outside property lines of the uncapped onsite disposal areas (e.g., Western Disposal Areas, areas of the Panelyte Marsh, Panelyte Property, and Conrail Property) would be excavated and consolidated into the uncapped onsite disposal areas to create a setback from adjacent properties. PCB-containing sediments in the Former Monarch Raceway Channel would also be consolidated in the Monarch HRDL. The PCB-containing materials consolidated into the existing uncapped onsite disposal areas would be graded to a stable repose, then the areas would be covered with an impermeable engineered barrier (consistent with Michigan Act 451, Part 115 solid waste landfill cover regulations). The cap would be constructed with appropriate erosion controls and other measures to protect against events or incidents that might otherwise threaten the integrity of the disposal areas. The existing impermeable engineered landfill cap over the Bryant HRDL/FRDLs would be maintained in place, as would the sheetpile wall along the western bank of Portage Creek.

Both Alternative 4A and Alternative 4B would include long-term inspections and maintenance of the Alcott Street Dam and the new and existing impermeable barriers. In addition, a monitoring program would be implemented to provide for the appropriate management of landfill gas, and to verify that groundwater quality conforms to applicable risk-based standards.

Institutional controls (e.g., deed restrictions to prevent exposure of PCBs at depth, enforcement tools to facilitate the long-term O&M of the dam, perimeter fence with posted warning signs, permit tools, informational devices) would be implemented at outlying areas and the onsite disposal areas, as appropriate, to prevent actions that might result in direct contact with PCB-containing materials.

Alternatives 4A and 4B are described below.

4.4.1 Alternative 4A – Removal and Offsite Disposal of Selected Outlying Areas, Onsite Consolidation/Containment of Former Operational Areas beneath an Impermeable Engineered Barrier, Groundwater and Landfill Gas Monitoring, and Institutional Controls

<u>Description of Alternative</u>

Under Alternative 4A, approximately 40,500 cy of soil and/or sediment containing PCBs above the relevant PRGs would be excavated from selected outlying areas where structures or fill are not present to serve as a barrier to exposure (i.e., portions of Goodwill lawn area, Consumers

Power, Golden Age Retirement Community, the single-family residential properties, and the adjacent MHLLC property) (see Figure 4-6), then transported to and disposed in appropriately permitted offsite solid waste landfills. The excavated areas would be backfilled with clean material, graded, and revegetated to match the surrounding area.

In the outlying areas where there is a confirmed limited presence of PCBs above the relevant PRGs at locations that are below clean fill and/or structures that serve to mitigate direct contact (e.g., Alcott Street Parking Lot and the Goodwill building and parking lots), institutional controls such as deed restrictions, permit tools, and informational devices will be employed to prevent actions that might compromise existing conditions.

After consolidation of onsite PCB-containing materials that lie close to Portage Creek; in the Panelyte Marsh, Panelyte Property, and Conrail Property; and along the outside property lines of the Former Operational Areas (a total of approximately 225,000 cy), the Monarch HRDL, Type III Landfill, and Western Disposal Area would be contained beneath an impermeable engineered barrier (i.e., designed in accordance with Michigan Act 451, Part 115). The new barrier over these areas would cover approximately 28 acres. The existing impermeable engineered landfill cap over the Bryant HRDL/FRDLs and the existing sheetpile wall would be maintained in place.

4.4.2 Alternative 4B – Removal and Offsite Disposal of All Outlying Areas, Onsite Consolidation/Containment of Former Operational Areas beneath an Impermeable Engineered Barrier, Groundwater and Landfill Gas Monitoring; Institutional Controls

Description of Alternative

Under Alternative 4B, approximately 91,000 cy of soil and/or sediment containing PCBs above the relevant PRGs would be excavated from all offsite outlying areas other than the portion of the Goodwill property covered by buildings (see Figure 4-7), then transported to and disposed in appropriately permitted offsite solid waste landfills. The excavated areas would be backfilled with clean material, graded, and revegetated to match the surrounding area. The following areas would be excavated:

- portions of Goodwill lawn area
- Goodwill parking lots
- MHLLC's Alcott Street parking lot

- Consumers Power
- Golden Age Retirement Community
- the single-family residential properties and the adjacent MHLLC property

After consolidation of onsite PCB-containing materials that lie close to Portage Creek; in the Panelyte Marsh, Panelyte Property, and Conrail Property; and along the outside property lines of the Former Operational Areas (a total of approximately 225,000 cy), the Monarch HRDL, Type III Landfill, and Western Disposal Area would be contained beneath an impermeable engineered barrier (i.e., designed in accordance with Michigan Act 451, Part 115). The new barrier over these areas would cover approximately 28 acres. The existing impermeable engineered landfill cap over the Bryant HRDL/FRDLs and the existing sheetpile wall would be maintained in place.

4.5 Alternative 5 – Total Removal and Offsite Disposal (with or without Immobilization), Sheetpile Removal, Institutional Controls

Under Alternative 5, approximately 1,575,500 cy of soil and/or sediment containing PCBs above the relevant PRGs would be excavated and disposed offsite. There are two sub-alternatives – one that includes immobilization prior to disposal (Alternative 5B) and one that does not (Alternative 5A).

<u>Description of Alternative</u>

In both Alternative 5A and 5B, the following areas are targeted for excavation (see Figure 4-8):

- All offsite outlying areas other than the portion of the Goodwill property covered by buildings (i.e., portions of Goodwill lawn area, Goodwill parking lots, MHLLC's Alcott Street parking lot, Consumers Power, Golden Age Retirement Community, and the single-family residential properties and the adjacent MHLLC property)
- Former Operational Areas – the Monarch HRDL (including the Former Monarch Raceway Channel), Type III Landfill, Western Disposal Area
- Bryant HRDL/FRDLs

- Onsite areas with PCB-containing materials that lie close to Portage Creek; in the Panelyte Marsh, Panelyte Property, and Conrail Property; and along the outside property lines of the Former Operational Areas

These materials would be transported to and disposed in offsite landfills permitted to receive TSCA-regulated (i.e., materials with PCB concentrations of 50 mg/kg or higher) and non-TSCA materials (i.e., materials with PCB concentrations below 50 mg/kg), as appropriate. Excluded from removal are the PCB-containing materials that are located under existing buildings on the Goodwill property. The excavated areas would be backfilled with clean material, graded, and revegetated to match the surrounding area. The excavated and backfilled area would extend across approximately 65 acres.

After excavation, the materials would either be transported directly to the offsite commercial landfills (Alternative 5A), or first stabilized onsite using an immobilizing agent (e.g., cement) to bind PCBs within a monolith before being transported offsite for disposal (Alternative 5B).

Post-removal confirmatory sampling and analysis would be performed at the excavation areas. Once cleanup goals have been achieved, the excavated areas would be backfilled with clean material, graded to mitigate ponding, and revegetated. The Panelyte Marsh and Former Monarch Raceway Channel would be backfilled to existing grades and restored to promote the re-establishment of native vegetation.

In addition, as part of this alternative the 2,600 linear feet of sealed-joint sheetpile along the western bank of Portage Creek will be cut to 2 feet below grade, and the remainder of subgrade sheetpile left in place. The groundwater treatment system would be decommissioned and removed, and the network of groundwater extraction trenches, sumps, and wells currently in place behind the sheetpile wall would be removed and disposed. Further considerations associated with sheetpile removal are discussed in Section 4.8.

A long-term inspection and maintenance program would be implemented for the Alcott Street Dam. Institutional controls (e.g., deed restrictions, enforcement tools) would be implemented for the areas beneath the existing buildings on the Goodwill property to prevent actions that might result in direct contact with these materials.

4.6 Alternative 6 – Hazardous Waste Landfill Containment System, Sheetpile Removal, Institutional Controls

Under Alternative 6, approximately 1,575,500 cy of soil and/or sediment containing PCBs above the relevant PRGs would be excavated and then placed in a series of full-encapsulating containment disposal cells – equivalent to a hazardous waste landfill containment system – constructed onsite in the locations of the current Former Operational Areas. Some materials would be volumetrically displaced, and would be disposed in offsite commercial landfills.

Description of Alternative

The same areas identified in Alternative 5 are targeted for excavation in Alternative 6 (see Figure 4-9). Excluded from removal are the PCB-containing materials that are located under existing buildings on the Goodwill property.

In the outlying areas, once cleanup goals have been achieved, the excavated areas would be backfilled with clean material, graded to mitigate ponding, and revegetated. The Panelyte Marsh and Former Monarch Raceway Channel would be backfilled to existing grades and restored to promote the re-establishment of native vegetation.

All excavated materials onsite and from the outlying areas would be sequentially stockpiled onsite during construction of a series of hazardous waste landfill containment cells – equivalent to a hazardous waste landfill containment system – constructed onsite in the locations of the current Former Operational Areas. Post-removal confirmatory sampling and analysis would be performed at the excavation areas.

Work in the Former Operational Areas could potentially be carried out in this manner:

- Excavate soils from the Monarch HRDL, temporarily stage the soils in the Western Disposal Area. Backfill the Monarch HRDL with approximately 10 feet of imported clean fill to establish the necessary base elevation for the disposal cell. Construct the base liner, transport approximately 75% of the excavated Monarch HRDL soils back to the Monarch cell, place/grade/compact the soils, construct the final cover system. The remaining 25% of soils volumetrically displaced would be transported offsite for disposal.

- Repeat the above process for the Bryant HRDL/FRDLs, then the Former Type III Landfill.

- Repeat the above process for the western half of the Western Disposal Area, but do not construct the final cover system.

- Complete the process for the eastern half of the Western Disposal Area, then construct the final cover system over the entire Western Disposal Area.

The containment system disposal cells would be designed and built in accordance with Michigan Act 451 Part 111 hazardous waste regulations. The cells would include a double composite base liner system constructed a minimum distance of 10 feet above the groundwater table and graded to a minimum slope of 2 percent to promote drainage.

The liner system would consist of the following components, from top down: a 40-mil primary FML, underlain by a geosynthetic clay liner (GCL), a leachate collection system consisting of a geosynthetic drainage composite (GDC) layer (consisting of a geonet that is heat-bonded on each side to a non-woven needle-punched geotextile) draining to a pumpable sump system, a leak detection system, a secondary 40-mil FML, and a secondary 3-foot compacted clay liner (or geosynthetic equivalent). The GCL would have a maximum hydraulic conductivity of 10^{-7} centimeters per second (cm/sec), and the GDC would have a minimum transmissivity of 3×10^{-4} meters^2 sec.

The removed materials would be placed within the disposal cells with a cover liner system sloped to grades of no less than 4 percent and consisting of the following components, from top down: a 6-inch vegetative soil layer, a 24-inch protective soil layer, a GDC (as described above), a 40-mil FML, a GCL, a non-woven needle-punched geotextile, a minimum 12-inch gas venting layer with gas vents at appropriately spaced intervals, a basal non-woven needle-punched geotextile, and a soil grading layer. The cap would be constructed with appropriate erosion controls and other measures to protect against flood events and other natural or human-induced incidents that might otherwise threaten the integrity of the disposal areas. The final cover system would cover approximately 50 acres.

Excess excavated materials that do not fit in the hazardous waste landfill containment cells (height of the cells is limited due to the need to attain the desired side slope grade) would be transported to and disposed of in appropriately permitted offsite solid waste landfills. Approximately 25% of the soils targeted for excavation and re-emplacement in the Former Operational Areas and all of the soils excavated from the offsite outlying areas would be volumetrically displaced, which means that more than 460,000 cy of materials would have to be transported offsite for disposal.

In addition, as part of this alternative the 2,600 linear feet of sealed-joint sheetpile along the western bank of Portage Creek will be cut to 2 feet below grade, and the remainder of subgrade sheetpile left in place. The groundwater treatment system would be decommissioned and removed, and the network of groundwater extraction trenches, sumps, and wells currently in place behind the sheetpile wall would be removed and disposed. Further considerations associated with sheetpile removal are discussed in Section 4.8.

Alternative 6 would also include long-term inspections and maintenance of the Alcott Street Dam and the hazardous waste landfill containment cells. In addition, a monitoring program would be implemented to provide for the appropriate management of landfill gas, and to verify that groundwater quality conforms to applicable risk-based standards.

Institutional controls (e.g., deed restrictions to prevent exposure of PCBs at depth, enforcement tools to facilitate the long-term O&M of the dam, perimeter fence with posted warning signs, permit tools, informational devices) would be implemented for the onsite disposal areas to prevent actions that might result in direct contact with PCB-containing materials.

4.7 Contingent Groundwater Remedy

All remedial alternatives other than Alternative 1 (No Further Action) will include a groundwater monitoring program. A groundwater monitoring network consisting of existing and new monitoring wells (as needed) will be located either along the outside perimeter of the Former Operational Areas (i.e., Bryant HRDL/FRDLs and, depending on the alternative, the Type III Landfill, Western Disposal Area, and/or Monarch HRDL) or the former locations of these disposal areas. The monitoring wells will be sampled on a semi-annual basis and analyzed for PCBs, selected inorganic constituents, and field parameters (temperature, pH, conductivity, turbidity, oxidation-reduction potential).

Following each sampling event, the analytical results will undergo data validation, and the validated PCB analytical results will be compared to Michigan Act 451 Part 201 Generic Screening Criteria. Analytical results from groundwater samples collected from monitoring wells adjacent to Portage Creek will be compared to the GSI criterion of 0.2 µg/L.

Contingency actions will be undertaken in the event that PCB levels in groundwater samples exceed the corresponding GSI criterion. In this circumstance, the USEPA will be notified and the following contingency actions will be implemented. This proposed approach is based on the post-closure program established in the *King Highway Landfill Operable Unit - Hydrogeologic Monitoring Plan* (BBL 2002), developed for another OU of the Kalamazoo River Superfund Site.

1. An additional groundwater sample will be collected from the well(s) where the previous sample PCB concentration(s) exceeded the GSI criterion.

2. The analytical data associated with the re-sample(s) will be validated and compared to the appropriate criterion.

3. If the subsequent validated PCB concentration value is less than the applicable GSI criterion, normal sampling frequency will resume.

4. If the subsequent validated PCB concentration remains greater than the applicable GSI criterion, the sampling frequency will be increased to monthly.

5. Monthly groundwater sampling will continue until sufficient data points are obtained to establish a trend in PCB concentration(s). The increased sampling frequency could be continued for a longer time period if necessary to determine the potential impacts of seasonal or other variations caused by other effects. If the data indicate that the PCB concentration(s) is trending towards the applicable GSI criterion and is expected to decrease below criterion within a reasonable timeframe, then sampling will continue at the increased frequency until the PCB concentration(s) is at or below the applicable GSI criterion. Once this value is confirmed to be at or below the applicable GSI criterion, the sampling frequency will return to normal.

6. If the data trend indicates that the PCB concentration(s) continues above the applicable GSI criterion, a plan to assess the nature and extent of PCBs in groundwater will be developed and submitted to USEPA for review and approval. If, during the course of implementing the plan, validated PCB concentrations fall below the applicable GSI criterion, no further action will be taken, and the sampling frequency will return to normal.

7. If, following the assessment of nature and extent validated PCB concentrations remain above the applicable GSI criterion and significant risks are identified, a plan to develop appropriate remedial alternatives based on the risk to human health and the environment will be prepared and submitted to USEPA for review and approval.

8. Upon USEPA approval, the assessment of remedial alternatives will be conducted and the most appropriate technology will be identified, designed (with USEPA approval), and constructed. An O&M plan will be prepared as appropriate to the technology(ies) used for the remedy. Potential remedial technologies may include localized removal of source material, installation of recovery wells and/or trenches, vertical barriers (e.g., slurry walls), or funnel and treatment gate systems; implementation of ex-situ treatment (e.g., filtration, chemical flocculation, gravity settling, activated carbon), or others as appropriate.

4.8 Maintenance or Removal of Sheetpile

The sheetpile that currently runs along the western bank of Portage Creek was installed during the IRM (as described in Section 1.3.2) to provide stability to the materials within the Bryant

HRDL/FRDLs along Portage Creek. The sheetpile is currently functioning as designed and it is routinely inspected. During development of the range of alternatives to be considered in the FS, the USEPA requested that removal of the sheetpile along the Bryant HRDL/FRDLs be evaluated as a component of a remedy evaluated in this FS (USEPA 2009). Sheetpile removal is explicitly incorporated as part of the complete removal alternative (Alternative 5) and the hazardous waste landfill containment system alternative (Alternative 6). For the in-place containment alternatives (Alternatives 2, 3, and 4), sheetpile removal is not included since it would: 1) present significant short-term risks to workers and the community, 2) increase the time of construction, and 3) increase costs without providing additional benefits relative to long-term effectiveness or permanence. These issues are described in Section 4.8.3.

To comply with USEPA’s request, in the following sections the approach to removing the sheetpile is presented followed by a discussion of the issues raised by USEPA associated with long-term maintenance of the sheetpile. In Section 4.8.3, the two approaches (removal and in-place maintenance) are compared with respect to relevant CERCLA evaluation criteria.

4.8.1 Considerations for Sheetpile Removal

The approach to sheetpile removal depends, in part, on the remedial alternative to be implemented. Under alternatives in which PCB-containing soils and residuals are entirely removed from the OU (Alternative 5) or relocated prior to onsite disposal in a hazardous waste landfill containment system (Alternative 6), the sheetpile could simply be cut off two feet below final grade in accordance with City of Kalamazoo ordinances. The exposed sections of the sheetpile would be scrapped for recycling and the subsurface sections would be abandoned in place. Under Alternatives 5 and 6, the sheetpile would not be removed to address a specific RAO, but to remove a remnant structure that would affect the overall aesthetics at the property. This approach, including the estimated cost, is already included as a component of Alternatives 5 and 6.

If the sheetpile were removed as a component of an in-place containment remedy (i.e., Alternatives 2, 3, or 4) despite the additional short-term risks to workers and the community, increased time of construction, and increased costs, the approach to sheetpile removal would be more complex than for Alternatives 5 and 6. Removal of the sheetpile under the in-place containment alternatives would necessarily entail removal of the existing cap and soils/residuals within the perimeter of the Bryant HRDL/FRDLs, adjacent to the sheetpile. A conservative estimate of 125,000 cy of existing cap material and soils/residuals would need to be excavated and pulled back from the sheetpile wall. The existing cap and PCB-containing material would need to be reconsolidated onto the Bryant HRDL/FRDLs, relocated to another area of the OU (i.e., other Former Operational Areas), or transported offsite (TSCA landfill and/or solid waste landfill) for permanent disposal. The final destination for these materials would be determined during the design phase, as it is dependent on the volume of materials removed and the space available in potential onsite disposal areas. Soil confirmation samples also would need to be collected after removal activities to verify that remaining materials meet the PCB PRG for soils. The sheetpile would likely be kept in place during the cap and soil/residuals removal operations and the early cap reconstruction activities to maintain erosion and sedimentation controls. The sheetpile wall would then be cut off two feet below design grade and the toe of the cap would terminate some distance from the former location of the sheetpile wall. The removed sheets would be salvaged for recycling. To reconstruct the edge of the cap, new cap materials would need to be installed across an area conservatively estimated to cover approximately 6 acres – this is in addition to the materials that would be necessary to implement Alternatives 2, 3, or 4 as described in Sections 4.2, 4.3, and 4.4, respectively.

4.8.2 Considerations for Maintaining the Sheetpile In Place

If the sheetpile along the Bryant HRDL/FRDLs area remains in place, as currently contemplated in Alternatives 2, 3, and 4, provisions will be made to maintain its long-term integrity and protectiveness and ensure that groundwater can be effectively monitored. Also, in the event that the groundwater extraction system is shut down, actions may be required to prevent groundwater mounding behind the sheetpile that might otherwise present a concern for cap maintenance. The USEPA has raised two possible concerns with the sheetpile remaining in place: a loss of structural stability in the long term, and the potential inability to monitor groundwater adequately. Each of these concerns is discussed below.

4.8.2.1 Long-Term O&M of Sheetpile

The long-term structural stability of sheetpile directly relates to the electrochemical process of corrosion, which oxidizes the steel and over time reduces the strength of sheetpile wall. This reaction occurs in aerobic environments in which both water and oxygen are available to react with iron in the steel. Sheetpile corrosion rates correlate to the pH of the soil and groundwater in the immediate vicinity, and the thickness of the sheetpile. The AZ-13 and AZ-18 sheets of steel installed at the Allied OU have a nominal thickness of 0.031 feet (approximately 0.4 inches), and the average groundwater pH measured in monitoring wells installed along the sheetpile during the RI was 7.0, indicating a neutral environment. In the absence of any protective measures, the rate of sheetpile corrosion in this type of non-aggressive environment can be expected to be as low as 0.0005 inches per year (Allen and Clarke 1996). At this rate it would take several hundred years to corrode the sheetpile wall to the point of structural failure. However, sheetpile longevity can be significantly lengthened using cathodic protection to inhibit rusting. A controlled cathodic protection system, such as the use of sacrificial aluminum anodes, can be installed around the sheetpile to preferentially corrode in preference to the sheetpile structure itself. The cathodic protection can be further enhanced by other measures, such as the use of an impressed DC current. Other readily implementable measures to lengthen the useful life of the sheetpile include coating the steel with an epoxide paint or encasing the sheetpile in concrete.

Displacement of the sheetpile can easily be monitored using inclinometers placed at selected points along the wall, or other means, to assess potential ongoing movement. In the event that unacceptable displacement occurs, the sheetpile could be shored up with the installation of additional steel sheeting to strengthen the wall and facilitate its long-term structural stability. With these O&M approaches, the effective life of a sheetpile wall is virtually indefinite, and should not be considered a detrimental factor in assessing the long-term protectiveness of the existing containment system at the Bryant HRDL/FRDLs.

4.8.2.2 Groundwater Mounding and Monitoring

If, as discussed in Section 1.8, the groundwater extraction system were to be shut down at the Allied OU, groundwater levels within the Bryant HRDL/FRDLs area would be expected to rise and potentially mound up behind the sealed-joint sheetpile wall. Under an in-place containment remedy this may raise maintenance issues for the cap. It is anticipated that groundwater elevation monitoring would be conducted in conjunction with shut down of the groundwater extraction system, and the cap and sheetpile inspected to assess the potential effects of rising groundwater elevations. If groundwater mounding is determined to be problematic, an evaluation will be made at that time to develop alternatives for addressing the problem(s).

Moreover, even if the groundwater extraction system is shut down, the in-place containment alternatives (Alternatives 2, 3, and 4) include a provision to continue monitoring groundwater to verify that PCBs are not migrating offsite (in compliance with RAO 3). An extensive groundwater monitoring well network currently exists along the sheetpile wall at the Allied OU, consisting of 57 monitoring wells and piezometers. Given the considerable volume (635,000 cy) and layout of PCB-containing material contained within the Bryant HRDL/FRDLs, many of the wells and piezometers were constructed through the disposal area into the underlying geology. The extensive monitoring well network is shown on a series of figures (4-10 through 4-13) drawn from the RI Report. A map view of the layout of the well network is shown on Figure 4-10. Figure 4-11 presents cross-section D-D’, drawn parallel to the creek, which shows a detailed view of the several dozens of wells and piezometers that compose the existing well network along the sheetpile, as well as the upper and lower elevation of the entire sheetpile wall. This figure also illustrates how the wells were constructed to intercept potential preferential groundwater flow paths where they are most expected to exist in sand seams and shallow segments of the sheetpile wall. Figures 4-12 and 4-13 depict groundwater flow nets perpendicular to the creek, and show the locations of well screens relative to groundwater flow paths that lead to Portage Creek.

The well network along the sheetpile wall was constructed specifically to monitor groundwater that is within and downgradient of the Bryant HRDL/FRDLs, and upgradient of Portage Creek. In the south area of the disposal area where the sheetpile is immediately adjacent to the creek, the zone between the base of the disposal area and the creek is narrow, and may not allow for a lengthy travel time for groundwater before it discharges to the creek. However, as discussed in Section 1.7, based on the results of the data screening evaluation in which the analytical results of groundwater samples collected from the monitoring well network were compared to USEPA PRGs and MDEQ Act 451 Part 201 GSI criteria, no COCs have been identified for groundwater. Therefore, the limited horizontal distance of the monitoring zone between the Bryant HRDL/FRDLs and Portage Creek is of little practical concern. Removal of the sheetpile is not expected to significantly (if at all) enhance the ability to effectively monitor groundwater at the Allied OU – wells closer to the creek will not necessarily improve upon the existing well network at intercepting groundwater that is discharging to the creek. The existing monitoring well network along the sheetpile wall is an effective system that can be used for long-term groundwater monitoring along the sheetpile wall within the Bryant HRLD/FRDLs disposal area for those alternatives in which in-place containment is contemplated as part of the final remedy.

4.8.3 Summary Comparison of the Two Approaches

In this section, selected CERCLA criteria are used to highlight the differences between the two approaches: 1) removing the sheetpile along Portage Creek and setting back the existing cap over the Bryant HRDL/FRDLs and 2) leaving the existing cap and sheetpile in place.

Long-Term Effectiveness and Permanence: Removal of the sheetpile as part of Alternatives 2, 3, or 4 would not provide any significant improvement in the long-term effectiveness or permanence of those remedies. The sheetpile wall can be maintained indefinitely, as can the set-back edge of the landfill cover with the sheetpile removed. Both approaches are proven and reliable, and groundwater monitoring can be conducted in an equally effective manner under either scenario. Removal of the sheetpile would not be more effective in reducing exposure or potential risks to human health or the environment relative to existing conditions at the Bryant HRDL/FRDLs area.

Short-Term Effectiveness: In contrast, removal of the sheetpile as part of Alternative 2, 3, or 4 would significantly increase the potential for short-term impacts to human health and the environment during the period of implementation. As part of this approach, an estimated

125,000 cy of PCB-containing soils and clean cap material would have to be removed/handled and 38,700 cy of additional cap materials would have to be trucked in to reconstruct the edge of the cap (these quantities are in addition to the materials that would be handled/needed as part of implementation of Alternatives 2, 3, or 4). Assuming the use of standard 50 ton dump trucks, approximately 3,600 more trips would be necessary to haul the excavated material for disposal either onsite and/or offsite, and to import clean materials needed for reconstruction of the cap. Given the large volume of additional materials that would be transported to and from the Allied OU under the sheetpile removal scenario, short-term impacts to traffic, noise levels in the vicinity of the OU, and wear and tear to the local streets would all be expected to increase relative to leaving the sheetpile in place. Depending on the number of truck miles driven for this effort, there would also be an increased risk of onsite and offsite vehicle accidents and driver injuries.

Although preventive measures such as dust suppression, erosion controls, and storm water management would be employed as part of the removal and cap reconstruction activities, during the period of construction there would be an increased risk of worker exposure by direct contact and ingestion of PCBs, as well as an increased risk of PCB releases to Portage Creek. Removal of the sheetpile would also add up to one full year for completion of Alternatives 2, 3, and 4 – this is significant given that these alternatives as currently described could be completed in two years.

Cost: The cost for sheetpile removal with onsite consolidation, limited offsite disposal, and cap reconstruction is expected to be high relative to the cost of the containment remedies themselves. A key factor in determining the cost for sheetpile removal is the volume of material that must be disposed offsite at a solid waste facility or TSCA facility due to limitations in disposal capacity in the Former Operational Areas onsite.

Summary: Maintaining the existing sheetpile and cap system in place as part of Alternative 2, 3, or 4 provides an appropriate level of protection for both human and ecological receptors without the short-term effectiveness challenges and additional time and costs associated with sheetpile removal and cap reconstruction. Sheetpile removal would result in the handling of 125,000 cy of PCB-containing soils and clean cap materials, which presents substantial additional short-term risks to workers and the community relative to the existing cap and sheetpile system, without any additional benefit in risk reduction. The long-term monitoring and maintenance elements of Alternatives 2, 3, or 4 would provide the necessary mechanisms to verify that the selected remedy is performing as anticipated over time, providing an effective and permanent technology.

Given that there are considerable cost and short-term impacts associated with sheetpile removal and cap reconstruction and no associated improvement or benefit in long-term effectiveness or risk reduction, maintaining the existing sheetpile and cap system is the preferred approach for the Bryant HRDL/FRDLs disposal area at the Allied OU.

5. Detailed Evaluation of Remedial Alternatives

USEPA guidance (1988) includes a step for screening alternatives in a general manner considering the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. The purpose of this screening step is to reduce the number of alternatives that will undergo a more thorough and extensive analysis, but at the Allied OU, all the alternatives developed and described in Section 4 will be carried forward.

The next phase of this FS is a detailed assessment of the alternatives compared to a set of criteria defined in CERCLA. The criteria and the key questions to be considered in the evaluation are:

- ***Overall Protection of Human Health and the Environment*** – This criterion is used to address the overall effectiveness of an alternative in protecting human health and the environment by reducing potential exposures and achieving the identified RAOs. Key questions are: Does the alternative reduce risks and maintain protectiveness over time? Are all RAOs met?

- ***Compliance with Applicable or Relevant and Appropriate Requirements*** – This criterion is used to assess whether a given alternative would comply with identified ARARs. The key question is: Does the alternative comply with all ARARs, or are waivers necessary?

- ***Long-Term Effectiveness and Permanence*** – This criterion is used to assess the effectiveness of a given alternative with respect to reducing exposure and potential risk and the ability to maintain protectiveness over time. The key question is: Does the alternative maintain protection of human health and the environment after RAOs have been met?

- ***Reduction of Toxicity, Mobility, or Volume through Treatment*** – This criterion is applied to assess expected reductions in toxicity, mobility, or volume of PCB-containing materials through treatment as a result of implementing an alternative. The key question is: Does the alternative use treatment to reduce the mobility, toxicity, or volume of PCBs?

- ***Short-Term Effectiveness*** – This criterion is used to assess short-term impacts to human health and the environment related to construction and implementation of the remedial alternative. Considerations include short-term environmental impacts of construction, the protection of onsite workers and the neighboring community, and the time until the RAOs are achieved. The key question is: How does construction of the alternative affect human health and the environment?

- ***Implementability*** – This criterion is used to assess the implementability of an alternative with respect to both technical and administrative feasibility, including the availability of appropriate services and materials. Technical implementability includes the ability to construct and operate the technology, the reliability of the technology, and the ability to effectively monitor the technology. Administrative feasibility includes the degree to which any coordination with other government agencies (including local governments) can be achieved. The key questions are: Is the alternative technically and administratively feasible? Are trained workers and necessary equipment and materials readily available? How long will the project take?

- ***Cost*** – In the development of costs, capital, O&M, and present worth costs of implementing an alternative are assessed. Present worth costs, where appropriate, are developed using a discount rate of 6% based on OSWER Directive No. 9355.3-20 (USEPA 1993). In consideration of engineering and construction contingencies, these feasibility-level costs are typically estimated with an accuracy in the range of +50% to -30%. The key question is: How much will it cost to implement and maintain the alternative and monitor its effectiveness?

Each alternative is evaluated individually relative to the seven criteria in this section, followed by a comparative assessment in Section 6. The results of these evaluations will be used by the USEPA in the identification of a recommended alternative for the OU.

The CERCLA criteria of State Acceptance and Community Acceptance are typically addressed by USEPA following the comment period on the Proposed Plan. Agency Acceptance is specifically addressed in the development of the Record of Decision (ROD), and USEPA addresses Community Acceptance by developing a Responsiveness Summary that is included in the ROD.

5.1 Alternative 1 – No Further Action

Development of a no further action alternative is required under the NCP. The no further action alternative provides a comparative baseline against which other alternatives can be evaluated. Under Alternative 1, no further remedial action would be taken beyond the already completed TCRA in the Former Bryant Mill Pond and the IRMs (described in Section 1.3.2) carried out across the OU, and the PCB-containing soils and residuals would be left in place, without the implementation of any further containment, removal, treatment, or other mitigating actions.

Natural attenuation processes would continue, but environmental media at the OU would not be monitored to gauge progress toward the RAOs. This alternative does not provide for any active or passive institutional controls to reduce the potential for exposure (e.g., physical barriers, deed restrictions), nor does it address the existing potential risks to humans and ecological receptors associated with the Allied OU.

5.1.1 Overall Protection of Human Health and the Environment

Under Alternative 1, no further remedial actions would be taken, the existing engineered cap over the Bryant HRDL/FRDLs would not be inspected or maintained, the sheetpile along the western bank of Portage Creek would not be maintained, and no institutional controls would be put in place to restrict access to the OU or prevent the use of groundwater. Further, the potential for exposure to materials with PCB concentrations above applicable PRGs would remain.

Although current conditions at the Allied OU are generally stable relative to the ongoing potential for migration of PCBs and many source areas have been addressed, Alternative 1 provides no improved protection over the current conditions, provides no additional risk reduction, and is not expected to be protective of human health and the environment over the long term. The TCRA and IRMs completed to date have substantially satisfied the RAOs, but current exposure and potential risks in the outlying areas and portions of the Allied OU where IRMs have not been implemented would persist. Risks may actually increase over time if PCBs in the uncapped disposal areas (i.e., Monarch HRDL, Type III Landfill, Western Disposal Area) became exposed and eroded into Portage Creek, the sheetpile wall failed, or the engineered cap were compromised and PCB-containing materials that are currently isolated/contained were exposed or released. Only RAO 4 would be achieved – since no remedial actions would be carried out, there would be no risks associated with implementation.

5.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Since no active remedial efforts are proposed under Alternative 1, most of the action- and location-specific ARARs do not apply. Specific ARARs that would not be achieved if Alternative 1 were selected are summarized below.

- **Part 201, Environmental Remediation, of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended (Part 201).** This state ARAR provides for the identification, risk assessment, evaluation, and remediation of contaminated sites within the state. At sites of environmental contamination, this ARAR established generic cleanup criteria, and allows development of additional site-specific criteria to protect the environment, considering ecological risks (Section 20120(a)(17)). Alternative 1 would not reduce exposure or associated risk and would not achieve a degree of protectiveness for the property, as required in Part 201's Sections 20120a and 20120b. The potential for exposure to PCB-containing residuals/soils would still exist, as would the potential migration of PCB-contaminated material. Alternative 1 could not satisfy the requirements for long-term monitoring, would not achieve the requirement to restrict future land use, and would not comply with Part 201 if there is transport of PCBs to surface water.

- **Part 115, Solid Waste Management, of the NREPA, 1994 PA 451, as amended (Part 115).** This state ARAR establishes the requirements for methods of solid waste disposal and for design/operational standards for disposal areas. Selection of Alternative 1 would not meet the various relevant criteria included in this act identified in Table 2-2.

5.1.3 Long-Term Effectiveness and Permanence

As Alternative 1 would not lead to achievement of RAOs 1, 2, or, 3, it also would not provide or maintain protection of human health or the environment over the long term. The potential for exposure to PCBs in areas where IRMs have not been implemented would remain, and the potential for the long-term effectiveness of the existing engineered cap and sheetpile to be compromised would increase over time if the current inspection and maintenance program were discontinued. As a result, the potential for unacceptable long-term risks to human health and the environment would remain.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

As Alternative 1 does not include any active remedial components, it does not address the federal statutory preference for a remedy that employs treatment technologies that permanently and significantly reduce the mobility, toxicity, or volume of PCB-containing materials through treatment.

5.1.5 Short-Term Effectiveness

Since no active remedial measures are proposed as part of Alternative 1, there is no potential for short-term adverse impacts associated with construction or implementation. However, since existing measures in place to control access to the OU would not be maintained, there could be an increased risk of dermal exposure over the short-term if individuals trespassed onto the property and came in contact with surficial materials containing PCBs.

5.1.6 Implementability

Alternative 1 would be both technically and administratively implementable because no active remediation would be taken. No equipment or specialized services would be required to implement the alternative, and no specific approvals would be necessary.

5.1.7 Cost

No capital or O&M costs are associated with the selection of Alternative 1.

5.2 Alternative 2 –Onsite Consolidation/Containment beneath an Earthen Cover, Institutional Controls

Alternative 2 generally includes in-place containment of PCB-containing materials under an earthen cover. In Alternative 2A, select offsite outlying areas would be contained in-place under an earthen cover, while in Alternative 2B, select offsite outlying areas would be excavated and consolidated onsite. In both sub-alternatives, the Monarch HRDL, Type III Landfill, and Western Disposal Area would be contained under an earthen cover, designed to be consistent with Michigan Act 451, Part 115 solid waste landfill cover regulations.

This approach would also include long-term inspections and maintenance of the Alcott Street Dam and the new/existing engineered barriers, monitoring of landfill gas and groundwater, and institutional controls.

5.2.1 Overall Protection of Human Health and the Environment

Alternative 2 is expected to be an effective remedy for protection of human health and the environment, as it would eliminate the potential for direct contact with PCB-containing materials, reducing risks to human and ecological receptors. PCB-containing materials that are not currently isolated would be covered in-place with an earthen cover or consolidated and covered with an earthen cover, thus preventing direct contact. The existing impermeable engineered landfill cap over the Bryant HRDL/FRDLs and existing soil cover or structures in outlying areas would be maintained in place.

Since PCBs would be left in place onsite and in some offsite outlying areas, implementation of institutional controls and the monitoring and maintenance components of the remedy would be critical to maintaining protectiveness over time. Both sub-alternatives would achieve RAO 1 by mitigating the potential for human and ecological exposure to materials containing PCBs above the relevant PRGs, via excavation/consolidation and installation/maintenance of earthen covers or impermeable barriers. Implementation of Alternative 2 would also achieve RAO 2, since all materials with PCB concentrations above relevant PRGs would be stabilized and contained under an earthen cover, thus mitigating the potential for migration to Portage Creek or onto adjacent properties. With respect to RAO 3, institutional controls would be established to further restrict groundwater use, and both Alternative 2A and 2B would be expected to maintain the current condition in which no groundwater with PCB concentrations exceeding applicable criteria is migrating to the creek or offsite. The installation of earthen covers and maintenance of existing barriers would virtually eliminate surface water infiltration. The potential for subsurface groundwater migration into Portage Creek would persist; however, the long-term groundwater monitoring program would verify that groundwater conforms to the applicable risk-based standards. As discussed more under the Short-Term Effectiveness criterion, risks associated with implementation could be effectively managed, though the slightly more intrusive nature of Alternative 2B (given the excavation of 40,500 cy of materials from offsite outlying areas) would carry additional short-term risks.

Alternative 2 would include a long-term inspection and maintenance program for the Alcott Street Dam, the existing sheetpile, the existing cap over the Bryant HRDL/FRDLs, and the newly consolidated/isolated areas. In addition, this alternative includes a long-term monitoring program to provide for the appropriate management of landfill gas, and a contingent groundwater remedy may be implemented if necessary and appropriate. These contingent measures and long-term inspection and maintenance activities would be conducted to verify that the remedy is functioning as intended, and allow for intervention if necessary. This would further provide for protection of human health and the environment.

Overall protection of human health and the environment is expected to be achieved upon completion of the consolidation activities and installation of the earthen cover (anticipated to take two years). Institutional controls would require maintenance of all engineered barriers, which would provide for long-term protection of human health and environment.

5.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 2 would achieve the action- and location-specific ARARs that apply to Alternative 2. These specific ARARs are summarized below.

- **Part 201, Environmental Remediation, of the NREPA, 1994 PA 451, as amended (Part 201).** This state ARAR provides for the identification, risk assessment, evaluation, and remediation of contaminated sites within the state. At sites of environmental contamination, this ARAR established generic cleanup criteria, and allows development of additional site-specific criteria to protect the environment, considering ecological risks (Section 20120(a)(17)). Alternative 2 would reduce the potential for exposure to PCB-containing residuals/soils, address the potential migration of PCB-contaminated material, and achieve a degree of protectiveness for the property, as required in Part 201's Sections 20120a and 20120b. Alternative 2 would satisfy the requirements for long-term monitoring and achieve the requirement to restrict future land use.

- **Part 115, Solid Waste Management, of the NREPA, 1994 PA 451, as amended (Part 115).** This state ARAR establishes the requirements for methods of solid waste disposal and for design/operational standards for disposal areas. By rule, the Allied OU is a "Sanitary Landfill, Type III" to which Type III standards apply. Selection of Alternative 2 would meet the various relevant criteria included in this act identified in Table 2-2 of this report.

- **Part 31, Water Resources Protection of the NREPA, 1994, PA 451, as amended (Part 31).** In accordance with the federal Water Pollution Control Act and the federal Clean Water Act, this state ARAR established state criteria for rivers, creeks, and floodplain areas, to protect aquatic life and human health. It also establishes water quality standards and monitoring requirements for discharge effluents including storm water and venting groundwater, specifying standards for several water quality parameters, including PCBs. Under Alternative 2, consolidation and isolation of PCB-contaminated materials beneath an earthen cover, combined with erosion control measures, would satisfy this ARAR.

- **Part 55, Air Pollution Control, of the NREPA (Part 55).** These are requirements regarding air emissions. Current PCB emissions are within acceptable limits. Because excavation of select PCB-containing materials and disturbance of the surface of the Allied OU during construction of earthen covers could result in increased air emissions, some care would be necessary in final design and remedial action to assure that construction methods do not result in unacceptable emissions. A Health and Safety Plan would be developed to monitor emissions, prevent worker and community exposure, and confirm compliance with this ARAR.

- **Occupational Safety and Health Act (29 Code of Federal Regulations [CFR] Parts 1910, 1926, and 1904).** The federal Occupational Safety and Health Act establishes health and safety requirements at sites on the NPL. This ARAR requires that workers and worker activities occurring during implementation of this alternative comply with training, safety equipment and procedures, monitoring, recordkeeping, and reporting requirements. Alternative 2 could meet this ARAR through development of a Health and Safety Plan outlining procedures to protect workers.

- **Rivers and Harbors Act (33 USC 403).** The federal Rivers and Harbors Act prohibits unauthorized obstruction of alteration of the navigable capacity of waters of the United States (fill, cofferdam, bulkheads, etc.), except on plans recommended and authorized by the Army Corps of Engineers. CERCLA response actions, however, do not require a permit in which the Corps of Engineers typically gives authorization. On CERCLA remedial activities, authority has been deferred to USEPA. The remedial action still must avoid unacceptable obstruction or alteration of Portage Creek. Alternative 2 would meet this ARAR with proper design and construction techniques.

- **Michigan Public Act 451, Part 303 – Wetlands Protection.** This ARAR establishes rules regarding wetland uses. This ARAR, which would be met by applying the proper standards in design, is applicable to Alternative 2 as materials that lie close to Panelyte Marsh will be excavated.

- **Part 91, Soil Erosion and Sedimentation Control of the NREPA, 1994 PA 451, as amended (Part 91).** This ARAR pertains to soil erosion, sedimentation, and control of erosion and sedimentation. The ARAR requires that an “earth change” (excavation, filling, or grading) be designed, constructed, and completed in a manner that limits the exposed area of any disturbed land for the shortest possible period of time, as determined by the local enforcing agency. It also requires the design of temporary or permanent control measures constructed for the conveyance of water around, through, or from the earth change area to limit the water flow to a non-erosive velocity. This ARAR requires installation and maintenance of temporary

5.2.3 Long-Term Effectiveness and Permanence

Implementation of Alternative 2 would generally be expected to meet the RAOs for the OU, be effective over the long term, and maintain protection of human health and the environment after the RAOs have been achieved. Isolation of PCB-containing materials under an earthen cover is a proven and reliable technology to prevent human and ecological exposure, and would also mitigate the potential for PCB-containing materials to migrate via air emissions, wind-blown particles, erosion, or surface water runoff into Portage Creek or onto adjacent properties. Stability of the OU and outlying areas would be improved as the areas where PCB-containing materials are left in place would be graded to a stable repose prior to the installation of the earthen covers.

Implementation of institutional controls and long-term monitoring and maintenance would provide for the long-term effectiveness and permanence of the earthen cover. The potential for failure of the earthen cover is low, as O&M activities would effectively identify future maintenance needs. Future use of the OU and potential long-term issues would be addressed through monitoring and institutional controls, including deed restrictions, signage, and fencing. The details of long-term monitoring and maintenance would be developed during remedial design and compiled into an O&M program.

Alternative 2 does not include active remediation of groundwater; however, implementation of a long-term groundwater monitoring program would confirm that groundwater quality conforms to applicable risk-based standards, and would mitigate the potential for groundwater with PCB concentrations exceeding applicable criteria to migrate to Portage Creek or offsite.

This alternative would effectively reduce risks over the long term, and the monitoring components and institutional controls would provide mechanisms to verify the remedy is performing as anticipated over time. If determined necessary, a contingent groundwater remedy may be implemented in conjunction with Alternative 2.

5.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 2 does not address the federal statutory preference for a remedy that employs treatment technologies that permanently and significantly reduce the mobility, toxicity, or volume of PCB-containing materials through treatment.

However, treatment is most important for constituents of concern that are mobile in the environment. As discussed in the RI Report and summarized in Section 1.4.2 of this report, PCBs tend to be relatively immobile in the environment, and at the Allied OU are most prone to migration where they are exposed to erosion. As a result, the isolation of PCB-containing materials in-place through consolidation beneath an earthen cover or maintenance of existing structures, clean fill, and impermeable cap is expected to effectively address the mobility of PCBs associated with potential migration. Alternative 2 would not provide any reduction in the volume or toxicity of PCB-containing materials.

5.2.5 Short-Term Effectiveness

Alternative 2 provides an acceptable degree of short-term effectiveness. There is the potential for a short-term increase in PCB exposure to workers due to potential disturbance of PCB-containing residuals as part of site preparation and implementation of the alternative; however, compliance with surface management and dust control procedures (appropriately wetting materials) and proper health and safety procedures (e.g., monitoring, use of personal protective equipment [PPE] as described in a Health and Safety Plan) to be developed during remedial design would effectively mitigate these short-term impacts and protect onsite workers from hazards during construction (e.g., working around heavy equipment). In the short-term, implementation of Alternative 2 would increase onsite traffic, which would increase noise, vibration, and vehicle fumes.

The primary short-term impacts to the community include increased noise, the potential for dust-borne releases, and increased traffic. The potential for noise issues and dust-borne releases is more significant with the implementation of Alternative 2B since that sub-alternative includes the disturbance of 3.0 acres of residential and commercial properties (the offsite outlying areas – these areas would be excavated in Alternative 2B, but either left undisturbed or covered with an earthen cover in Alternative 2A). Truck traffic in local residential neighborhoods would increase throughout the duration of the project, since materials for the earthen covers would have to be hauled to the project site. In Alternative 2B, materials excavated from the offsite outlying areas would have to be trucked over to the onsite consolidation/disposal areas and clean fill would have to be hauled in to fill the excavations – this would increase the number of vehicle trips relative to Alternative 2A. An estimated 11,000 truck trips to and from the OU would be necessary to implement Alternative 2A compared to 13,000 for Alternative 2B.

Short-term environmental impacts are associated with the potential for offsite migration due to dust-borne releases or incidental releases to Portage Creek. The dust-borne releases could be readily mitigated by keeping the excavation/consolidation areas/materials appropriately wet. Reasonable and appropriate controls (e.g., silt curtains) would be implemented when removing materials that lie close to Portage Creek and wetland areas of the Panelyte Marsh and Former Monarch Raceway Channel to mitigate impacts to the aquatic environment.

Areas disturbed during implementation would be restored after construction with appropriate native plantings (or restored as wetland areas, if appropriate), and the habitat in the impacted areas would be expected to recover quickly.

This alternative could be completed in two years. While the excavation work in Alternative 2B could be completed at any time, the installation of the earthen covers would have to be carried out during the standard Michigan construction season, which is typically late March or early April through the end of October, depending on weather.

5.2.6 Implementability

Implementation of Alternative 2 includes the following major components: excavation and consolidation, installation of earthen covers, installation of a storm water management system, landfill gas and groundwater monitoring, restoration, and O&M activities. All the process options incorporated into this alternative are proven and have been used successfully in numerous other environmental cleanup projects. Technologies for the installation of earthen covers are well established, widely applied, and are proven to be reliable over long time scales at sites of similar size and characteristics.

In Alternative 2A, installation of the earthen covers over the targeted offsite outlying areas is implementable using readily available, conventional earth-moving equipment. The excavation of targeted offsite outlying areas as part of Alternative 2B (an estimated 40,500 cy) is more complicated in comparison, but the excavation depths are not expected to be significant, the work areas should not have to be stabilized with sheeting or other materials, and readily-available conventional earth-moving equipment is expected to be sufficient. The excavation and consolidation activities proposed for the outside periphery of the Former Operational Areas and those areas that lie close to Portage Creek as well as the installation of the earthen cover over the Monarch HRDL, Former Type III Landfill, and the Western Disposal Area are also implementable using readily available, conventional earth-moving equipment.

The necessary services and sufficient quantities of construction materials are expected to be readily available, and qualified commercial contractors with experience at other Kalamazoo River Superfund Site OUs are available locally to perform the work.

Since the Allied OU is part of a CERCLA site, permits are not required for onsite activities; however, the substantive applicable requirements of federal and state regulations would need to be met.

5.2.7 Cost

Costs for Alternative 2 are associated with the following construction activities: project area preparation, excavation and consolidation, installation of earthen covers, storm water management, restoration, and long-term monitoring and maintenance. The estimated costs are presented in Table 5-1 (Alternative 2A) and Table 5-2 (Alternative 2B).

The total estimated capital cost associated with Alternative 2A is approximately $14.3 million, while the total estimated O&M cost is approximately $4.3 million. The total estimated 30-year present worth cost for Alternative 2A is approximately $18.6 million.

The total estimated capital cost associated with Alternative 2B is approximately $15.6 million, while the total estimated O&M cost is approximately $4.3 million. The total estimated 30-year present worth cost for Alternative 2B is approximately $19.9 million.

5.3 Alternative 3 – Onsite Consolidation/Containment beneath an Impermeable Barrier, Institutional Controls

Alternative 3 generally includes containment/consolidation of PCB-containing materials. In Alternative 3A, select offsite outlying areas would be contained in-place under an earthen cover, while in Alternative 3B, all offsite outlying areas would be excavated and consolidated onsite. In both sub-alternatives, the Monarch HRDL, Type III Landfill, and Western Disposal Area would be contained under an impermeable engineered barrier, designed to be consistent with Michigan Act 451, Part 115 solid waste landfill cover regulations.

This approach would also include long-term inspections and maintenance of the Alcott Street Dam and the new/existing engineered barriers, monitoring of landfill gas and groundwater, and institutional controls.

5.3.1 Overall Protection of Human Health and the Environment

Alternative 3 would be an effective remedy for the Allied OU – it would eliminate the potential for direct contact with PCB-containing materials onsite and in the offsite outlying areas, eliminate the potential for human and ecological receptors to be exposed to materials containing PCBs above the relevant PRGs, and reduce the potential for PCB-containing materials to migrate into Portage Creek or onto offsite properties. This would be accomplished through consolidation/containment under engineered barriers, long-term monitoring and maintenance, and institutional controls.

Since PCBs would be left in place onsite (and in the case of Alternative 3A, in offsite outlying areas), implementation of institutional controls and the monitoring and maintenance components of the remedy would be critical to maintaining protectiveness over time. Both sub-alternatives would achieve RAO 1 by mitigating the potential for human and ecological exposure to materials containing PCBs above the relevant PRGs, via excavation/ consolidation and installation of an earthen cover or impermeable barrier. Implementation of Alternative 3 would also achieve RAO 2, since all materials with PCB concentrations above relevant PRGs would be stabilized and contained under an engineered barrier (either earthen cover or impermeable barrier), thus mitigating the potential for migration to Portage Creek or onto adjacent properties. With respect to RAO 3, institutional controls would be established to restrict groundwater use, and both Alternative 3A and 3B would be expected to maintain the current condition in which no groundwater with PCB concentrations exceeding applicable criteria is migrating to the creek or offsite. The installation of an earthen cover or impermeable barriers and maintenance of existing barriers would virtually eliminate surface water infiltration. The potential for subsurface groundwater migration into Portage

Creek would persist; however, the long-term groundwater monitoring program would verify that groundwater conforms to the applicable risk-based standards. As discussed more under the Short-Term Effectiveness criterion, risks associated with implementation could be effectively managed, though the more intrusive nature of Alternative 3B (given the excavation of 91,000 cy of materials from offsite outlying areas) would carry additional short-term risks.

Alternative 3 would include a long-term inspection and maintenance program for the Alcott Street Dam, the existing sheetpile, the existing cap over the Bryant HRDL/FRDLs, and the newly consolidated/isolated areas. In addition, this alternative includes a long-term monitoring program to provide for the appropriate management of landfill gas, and a contingent groundwater remedy may be implemented if necessary and appropriate. These contingent measures and long-term inspection and maintenance activities would be conducted to verify that the remedy is functioning as intended, and allow for intervention if necessary. This would further provide for protection of human health and the environment.

Overall protection of human health and the environment is expected to be achieved upon completion of the consolidation activities and installation of the engineered barriers (anticipated to take two years). Institutional controls would require maintenance of all barriers, which would provide for long-term protection of human health and environment.

5.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

All the action- and location-specific ARARs that apply to Alternative 2 similarly apply to Alternative 3. As with Alternative 2, all the relevant ARARs would be achieved via the implementation of Alternative 3.

5.3.3 Long-Term Effectiveness and Permanence

The primary process options incorporated into Alternative 3 – excavation, consolidation, and installation of engineered barriers – are proven and reliable, and would be expected to provide long-term protection of human health and the environment after the RAOs have been achieved. The earthen cover (Alternative 3A) and impermeable engineered barriers (Alternative 3B) are proven and effective methods of isolating and eliminating potential contact with PCB-containing materials, and would mitigate the potential for PCB-containing materials to migrate via air emissions, wind-blown particles, erosion or surface water runoff, into Portage Creek or onto adjacent properties. Stability of the OU and outlying areas would be improved as the areas where PCB-containing materials are left in place would be graded to a stable repose prior to the installation of the barriers.

Implementation of institutional controls and long-term monitoring and maintenance would provide for the long-term effectiveness and permanence of the barrier. The potential for failure of the earthen cover or impermeable engineered barrier is low, as O&M activities would effectively identify future maintenance needs. Future use of the OU and potential long-term issues would be addressed through monitoring and institutional controls, including deed restrictions, signage, and fencing. The details of long-term monitoring and maintenance would be developed during remedial design and compiled into an O&M program.

Alternative 3 does not include active remediation of groundwater; however, implementation of a long-term groundwater monitoring program would confirm that groundwater quality conforms to applicable risk-based standards, and would mitigate the potential for groundwater with PCB concentrations exceeding applicable criteria to migrate to Portage Creek or offsite.

This alternative would effectively reduce risks over the long term, and the monitoring components and institutional controls would provide mechanisms to verify the remedy is performing as anticipated over time. If determined necessary, a contingent groundwater remedy may be implemented in conjunction with this alternative.

5.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 does not address the federal statutory preference for a remedy that employs treatment technologies that permanently and significantly reduce the mobility, toxicity, or volume of PCB-containing materials through treatment. As described under Alternative 2, treatment is most important for constituents of concern that are mobile in the environment. PCBs tend to be relatively immobile in the environment, and at the Allied OU are most prone to migration where they are exposed to erosion. Therefore, the consolidation/ containment components of this approach would reduce PCB mobility and exposure potential via isolation. There would be no reduction in volume or toxicity.

5.3.5 Short-Term Effectiveness

There are short-term risks associated with the implementation of Alternative 3, but these could be managed to provide appropriate protection to workers and the nearby community during construction. Although the excavation/consolidation/containment activities proposed as part of Alternative 3 present potential short-term increases in PCB exposure to workers during site preparation and implementation (due to either direct exposure or via dust-borne releases during the excavation/consolidation activities), potential health risks to onsite remediation workers would be mitigated through the use of appropriate health and safety practices and by compliance with a Health and Safety Plan.

The primary short-term impacts to the community include increased noise, the potential for dust-borne releases, increased traffic, and increased wear and tear on local roads. The potential for noise issues and dust-borne releases is more significant with the implementation of Alternative 3B since that sub-alternative includes the disturbance of 6.3 acres of residential and commercial properties (the offsite outlying areas – these areas would be excavated in Alternative 3B, but either left undisturbed or covered with an earthen cover in Alternative 3A). Truck traffic in local residential neighborhoods would increase throughout the duration of the project, since materials for the earthen cover and impermeable barriers would have to be hauled to the project site. In Alternative 3B, materials excavated from the offsite outlying areas would have to be trucked over to the onsite consolidation/disposal areas and clean fill would have to be hauled in to fill the excavations – this would increase the number of vehicle trips relative to Alternative 3A. An estimated 17,000 truck trips to and from the OU would be necessary to implement Alternative 3A compared to 22,000 for Alternative 3B.

The removal of PCB-containing materials beneath the Alcott Street and Goodwill parking lots under Alternative 3B would have a substantially greater potential for short-term impacts to neighboring properties/property owners than that of Alternative 3A. The excavations at these locations may reach 15 to 20 feet or more below grade, and are expected to require benching and/or sheetpile to allow removal to target depths. The installation and removal of sheetpile will create noise and cause vibrations in the immediate area during the period of construction, potentially disturbing nearby property owners/occupants.

Short-term environmental impacts are associated with the potential for offsite migration due to dust-borne releases or incidental releases to Portage Creek. The dust-borne releases could be readily mitigated by keeping the excavation/consolidation areas/materials appropriately wet. Reasonable and appropriate controls (e.g., silt curtains) would be implemented when removing materials that lie close to Portage Creek and wetland areas of the Panelyte Marsh and Former Monarch Raceway Channel to mitigate impacts to these environments.

Areas disturbed during implementation would be restored after construction with appropriate native plantings (or restored as wetland areas, if appropriate), and the habitat in the impacted areas would be expected to recover quickly.

This alternative could be completed in two years. While the excavation work in Alternative 3B could be completed at any time, the installation of the earthen cover and impermeable barriers would have to be carried out during the standard Michigan construction season, which is typically late March or early April through the end of October, depending on weather.

5.3.6 Implementability

Implementation of Alternative 3 includes the following major components: excavation and consolidation, installation of engineered barriers (either earthen cover or impermeable barrier), installation of a storm water management system, landfill gas and groundwater monitoring, restoration, and O&M activities. All the process options incorporated into this alternative are proven and have been used successfully in numerous other environmental cleanup projects. Technologies for the installation of engineered barriers are well established, widely applied, and are proven to be reliable over long time scales at sites of similar size and characteristics. This alternative could be completed in two years.

In Alternative 3A, installation of the earthen cover over the targeted offsite outlying areas is implementable using readily available, conventional earth-moving equipment. The excavation of targeted offsite outlying areas as part of Alternative 3B (an estimated 91,000 cy) is more complicated in comparison, particularly given that parking lots will have to be removed to access soils in certain areas and buildings are in close proximity to the areas targeted for action. Excavations in these areas could extend as deep as 15 to 20 feet below the ground surface. Given this depth and the adjacent buildings, the excavations would need to be stabilized with temporary steel sheeting. Special implementation methods will also be required to drive the sheets while minimizing the potential for damage to the adjacent structure (e.g., trenching and pre-drilling, pile driving using low vibratory methods, crack, vibration, and settlement monitoring).

In addition, excavating to a depth of 15 to 20 feet below the ground surface significantly increases the likelihood of encountering groundwater – as a result, supplemental engineering controls would be necessary in Alternative 3B to manage groundwater in the saturated fill. Such engineering controls would likely include a combination of excavation reinforcement (such as sheeting), dewatering, and soil stabilization. In addition, if a significant head differential exists between the groundwater table and the base of the excavation, a potential for creating hydrostatic pressure at the base of the excavation exists. Concerns relating to hydrostatic pressure may be minimized through engineering controls such as lengthening the flow path (e.g., if sheeting is used, increasing the embedment depth) and installing piezometers for monitoring vertical hydraulic gradients. While such groundwater management measures will present additional design and construction challenges, they are technically feasible and implementable.

The excavation and consolidation activities proposed for the outside periphery of the Former Operational Areas and those areas that lie close to Portage Creek as well as the installation of the impermeable engineered barrier over the Monarch HRDL, Former Type III Landfill, and the

Western Disposal Area are also implementable using readily available, conventional earth-moving equipment.

The necessary services and construction materials are expected to be readily available, and qualified commercial contractors with experience at other Kalamazoo River Superfund Site operable units are available locally to perform the work.

Since the Allied OU is part of a CERCLA site, permits are not required for onsite activities; however, the substantive applicable requirements of federal and state regulations would need to be met.

5.3.7 Cost

Costs for Alternative 3 are associated with the following construction activities: project area preparation, excavation and consolidation, installation of the earthen cover and impermeable barriers, storm water management, restoration, and long-term monitoring and maintenance. The estimated costs associated with the implementation of Alternative 3A and 3B are presented in Tables 5-3 and 5-4, respectively.

For Alternative 3A, the total estimated capital cost of implementation is $19.9 million, and the total estimated O&M cost is $4.3 million. The total estimated 30-year present worth cost associated with implementation of Alternative 3A is $24.2 million.

For Alternative 3B, the total estimated capital cost of implementation is $25.6 million, and the total estimated O&M cost is $4.3 million. The total estimated 30-year present worth cost associated with implementation of Alternative 3B is $29.9 million.

5.4 Alternative 4 – Removal and Offsite Disposal, Onsite Consolidation/Containment of Former Operational Areas, Institutional Controls

Alternative 4 generally includes removal and offsite disposal of the outlying areas and onsite containment under an impermeable barrier. In Alternative 4A, materials from selected offsite outlying areas where a potentially insufficient barrier exists would be excavated and disposed offsite, while in Alternative 4B, all offsite outlying areas (other than the portion of the Goodwill property covered by buildings) would be excavated and disposed offsite. In both sub-alternatives, after consolidation of PCB-containing materials close to Portage Creek; in the Panelyte Marsh, Panelyte Property, and Conrail Property; and in the periphery of the Former Operational Areas, the Monarch HRDL, Type III Landfill, and Western Disposal Area would be contained under an impermeable engineered barrier, designed to be consistent with Michigan Act 451, Part 115 solid waste landfill cover regulations.

This approach would also include long-term inspections and maintenance of the Alcott Street Dam and the new/existing engineered barriers, monitoring of landfill gas and groundwater, and institutional controls.

5.4.1 Overall Protection of Human Health and the Environment

Alternative 4 would be an effective remedy for the Allied OU – it would eliminate the potential for direct contact with PCB-containing materials onsite and in the offsite outlying areas, eliminate the potential for human and ecological receptors to be exposed to materials containing PCBs above the relevant PRGs, and reduce the potential for PCB-containing materials to migrate into Portage Creek or onto offsite properties. This would be accomplished through excavation and offsite disposal, consolidation/containment under impermeable engineered barriers, long-term monitoring and maintenance, and institutional controls.

Since PCBs would be left in place onsite, implementation of institutional controls and the monitoring and maintenance components of the remedy would be critical to maintaining protectiveness over time. Alternative 4 would achieve the RAOs in the same manner as described previously for Alternative 3. As discussed more under the Short-Term Effectiveness criterion, risks associated with implementation could be effectively managed.

As described for Alternatives 2 and 3, the protection of human health and the environment would be provided by the long-term inspection and maintenance program for the Alcott Street Dam, the existing sheetpile, the existing cap over the Bryant HRDL/FRDLs, and the newly consolidated/isolated areas; as well as the long-term landfill gas monitoring program. A contingent groundwater remedy may be implemented if necessary and appropriate to provide additional overall protection.

Overall protection of human health and the environment is expected to be achieved upon completion of the consolidation activities and installation of the impermeable barriers (anticipated to take two years). Institutional controls would require maintenance of all barriers, which would provide for long-term protection of human health and environment.

5.4.2 Compliance with Applicable or Relevant and Appropriate Requirements

In addition to the ARARs listed below, all the action- and location-specific ARARs that apply to Alternative 3 similarly apply to Alternative 4. As with Alternative 3, all the relevant ARARs would be achieved via the implementation of Alternative 4.

- **Resource Conservation and Recovery Act (RCRA) as amended by the Hazardous and Solid Waste Amendments Act of 1984.** This federal ARAR defines "solid waste" and "hazardous waste" setting forth handling and disposal requirements for each. A waste is defined as hazardous if it is specifically listed or exhibits the characteristics of being ignitable, corrosive, reactive, or toxic. Under Alternative 4, which involves offsite disposal, it would be appropriate to complete Toxicity Characteristic Leaching Procedure tests of the excavated materials to determine if the RCRA disposal requirements apply. If portions of the excavated materials are characteristic of hazardous waste, they would be subject to the transportation and disposal requirements under RCRA.

- **Michigan Public Act 300 of 1949 Michigan Vehicle Code.** This ARAR establishes rules to reduce the maximum axle loads during springtime frost periods. By restricting transport of heavy loads during frost periods, Alternative 4 would meet this ARAR.

- **U.S. Department of Transportation Placarding and Handling (40 CFR 171).** This ARAR regulates transportation and handling requirements for material containing PCBs with concentrations greater than 20 mg/kg. This ARAR is potentially applicable as PCB-containing materials in the offsite outlying areas may have PCB concentrations above 20 mg/kg.

5.4.3 Long-Term Effectiveness and Permanence

The primary process options incorporated into Alternative 4 – excavation, offsite disposal, consolidation, and installation of engineered barriers – are proven and reliable, and would be expected to provide long-term protection of human health and the environment after the RAOs have been achieved. The impermeable engineered barriers are proven and effective methods of isolating and eliminating potential contact with PCB-containing materials, and would mitigate the potential for PCB-containing materials to migrate via air emissions, wind-blown particles, erosion or surface water runoff into Portage Creek or onto adjacent properties. Stability of the OU and outlying areas would be improved as the areas where PCB-containing materials are left in place would be graded to a stable repose prior to the installation of the barriers.

Implementation of institutional controls and long-term monitoring and maintenance would provide for the long-term effectiveness and permanence of the barrier. The potential for failure of the impermeable barrier is low, as O&M activities would effectively identify future maintenance needs. Future use of the OU and potential long-term issues would be addressed through monitoring and institutional controls, including deed restrictions, signage, and fencing. The details of long-term monitoring and maintenance would be developed during remedial design and compiled into an O&M program.

Alternative 4 does not include active remediation of groundwater; however, implementation of a long-term groundwater monitoring program would confirm that groundwater quality conforms to applicable risk-based standards, and would mitigate the potential for groundwater with PCB concentrations exceeding applicable criteria to migrate to Portage Creek or offsite.

This alternative would effectively reduce risks over the long term, and the monitoring components and institutional controls would provide mechanisms to verify the remedy is performing as anticipated over time. If determined necessary, a contingent groundwater remedy may be implemented in conjunction with Alternative 4.

5.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 does not address the federal statutory preference for a remedy that employs treatment technologies that permanently and significantly reduce the mobility, toxicity, or volume of PCB-containing materials through treatment. However, under Alternative 4 the volume of PCB-containing material at the OU would be reduced through the excavation and offsite disposal. Approximately 40,500 cy of PCB-containing materials would be disposed offsite under Alternative 4A and approximately 91,000 cy of PCB-containing materials would be disposed offsite under Alternative 4B.

As described under Alternative 2, treatment is most important for constituents of concern that are mobile in the environment. PCBs tend to be relatively immobile in the environment, and at the Allied OU are most prone to migration where they are exposed to erosion. Therefore, the consolidation/ containment components of this approach would reduce PCB mobility and exposure potential via isolation. The toxicity of the material would not be changed.

5.4.5 Short-Term Effectiveness

There are short-term risks associated with the implementation of Alternative 4, but these could be managed to provide appropriate protection to workers and the nearby community during construction. Although the excavation/consolidation/containment activities proposed as part of Alternative 4 present potential short-term increases in PCB exposure to workers during site preparation and implementation (due to either direct exposure or via dust-borne releases during the excavation/consolidation activities), potential health risks to onsite remediation workers would be mitigated through the use of appropriate health and safety practices and by compliance with a Health and Safety Plan.

Similar to Alternative 3, the primary short-term impacts to the community include increased noise, the potential for dust-borne releases, increased traffic, and increased wear and tear on local roads. However, the potential for these short-term impacts, particularly increased traffic in the local residential neighborhoods, is greater for Alternative 4 than Alternative 3. The potential for noise issues and dust-borne releases is more significant with the implementation of Alternative 4B than 4A since that sub-alternative includes the disturbance of an additional 3.0 acres of residential and commercial properties.

Alternative 4 involves offsite disposal of PCB-containing materials from the outlying areas, which would require an increased number of trucks to transport excavated material for offsite disposal and to haul clean fill to the excavated areas. Truck traffic would increase with implementation of Alternative 4B, as approximately 91,000 cy of PCB-containing materials would be excavated for offsite disposal versus 40,500 cy under Alternative 4A. An estimated 22,000 truck trips to and from the OU would be necessary to implement Alternative 4A compared to 28,000 for Alternative 4B.

The removal of PCB-containing materials beneath the Alcott Street and Goodwill parking lots under Alternative 4B would have a substantially greater potential for short-term impacts to neighboring properties/property owners than that of Alternative 4A. The excavations at these locations may reach 20 feet or more below grade, and are expected to require benching and/or sheetpile to allow removal to target depths. The installation and removal of sheetpile will create noise and cause vibrations in the immediate area during the period of construction, potentially disturbing nearby property owners/occupants.

Short-term environmental impacts are associated with the potential for offsite migration due to dust-borne releases or incidental releases to Portage Creek. The dust-borne releases could be readily mitigated by keeping the excavation/consolidation areas/materials appropriately wet. Reasonable and appropriate controls (e.g., silt curtains) would be implemented when removing materials that lie close to Portage Creek and wetland areas of the Panelyte Marsh and Former Monarch Raceway Channel to mitigate impacts to these environments.

This alternative could be completed in two years. While the excavation work could be completed at any time, the installation of the impermeable barriers would have to be carried out during the standard Michigan construction season, which is typically late March or early April through the end of October, depending on weather.

Areas disturbed during implementation would be restored after construction with appropriate native plantings (or restored as wetland areas, if appropriate), and the habitat in the impacted areas would be expected to recover quickly.

5.4.6 Implementability

Implementation of Alternative 4 includes the following major components: excavation and offsite disposal or consolidation, installation of impermeable engineered barriers, installation of a storm water management system, landfill gas and groundwater monitoring, restoration, and O&M activities. All the process options incorporated into this alternative are proven and have been used successfully in numerous other environmental cleanup projects. Technologies for the installation of engineered barriers are well established, widely applied, and are proven to be reliable over long time scales at sites of similar size and characteristics. This alternative could be completed in two years.

Administratively, the disposal of PCB-containing materials in a licensed disposal facility is implementable; however finding a solid waste landfill in southwest Michigan that is available to accept the quantity of PCB-containing material that would be disposed offsite as part of Alternative 3B (91,000 cy) may be challenging. The disposal facilities commonly have limits on disposal capacity and disposal rates that may impact the timing of the cleanup project. It is reasonable to assume though that sufficient capacity would be available to implement either Alternative 3A or 3B without significant issues.

Excavation and offsite disposal or consolidation and installation of the impermeable barriers are implementable using readily available, conventional earth-moving equipment. As described for Alternative 3, the excavation of targeted offsite outlying areas as part of Alternative 4B (an estimated 91,000 cy) is more complicated in comparison to Alternative 4A, particularly given that parking lots will have to be removed to access soils in certain areas and buildings are in close proximity to the areas targeted for action. Excavations in these areas could extend as deep as 15 to 20 feet below the ground surface. Given this depth and the adjacent buildings, the excavations would need to be stabilized with temporary steel sheeting. Special implementation methods will also be required to drive the sheets while minimizing the potential for damage to the adjacent structure (e.g., trenching and pre-drilling, pile driving using low vibratory methods, crack, vibration, and settlement monitoring).

In addition, excavating to a depth of 15 to 20 feet below the ground surface significantly increases the likelihood of encountering groundwater – as a result, the same supplemental engineering controls described in the implementability section for Alternative 3 would be necessary in Alternative 4B to manage groundwater in the saturated fill. While these groundwater management measures will present additional design and construction challenges, they are technically feasible and implementable.

Excavation and consolidation of the outside periphery of the Former Operational Areas and those areas that lie close to Portage Creek as well as the installation of the impermeable engineered barrier are implementable using readily available, conventional earth-moving equipment.

The necessary services and construction materials are expected to be readily available, and qualified commercial contractors with experience at other Kalamazoo River Superfund Site OUs are available locally to perform the work.

Since the Allied OU is part of a CERCLA site, permits are not required for onsite activities; however, the substantive applicable requirements of federal and state regulations would need to be met.

5.4.7 Cost

Costs for Alternative 4 are associated with the following construction activities: project area preparation, excavation and offsite disposal or consolidation, installation of impermeable barriers, storm water management, restoration, and long-term monitoring and maintenance. The estimated costs associated with the implementation of Alternative 4A and 4B are presented in Tables 5-5 and 5-6, respectively.

For Alternative 4A, the total estimated capital cost of implementation is $23.5 million, and the total estimated O&M cost is $4.3 million. The total estimated 30-year present worth cost associated with implementation of Alternative 4A is $27.8 million.

For Alternative 4B, the total estimated capital cost of implementation is $31.3 million, and the total estimated O&M cost is $4.3 million. The total estimated 30-year present worth cost associated with implementation of Alternative 4B is $35.6 million.

5.5 Alternative 5 – Total Removal and Offsite Disposal (with or without Immobilization), Sheetpile Removal, Institutional Controls

Alternative 5 includes excavation and offsite disposal of PCB-containing materials. In Alternative 5B, excavated materials would be mixed with an immobilizing agent to create a monolith prior to disposal. In both sub-alternatives, all materials would be excavated from the Former Operational Areas; the Bryant HRDL/FRDLs; the areas that lie close to Portage Creek, the targeted portions of Panelyte Marsh, Panelyte Property, and Conrail Property; the offsite outlying areas other than the portion of the Goodwill property covered by buildings; and those areas in the periphery of the Former Operational Areas near adjacent properties (see Figure 4-8). After removal, excavation areas would be backfilled with clean material, covered with topsoil, and revegetated with native plants and grasses. Alternative 5 also includes cutting the sheetpile along the western bank of Portage Creek to a depth of 2 feet below grade, and abandoning the subsurface portion in place.

This alternative would also include long-term inspections and maintenance of the Alcott Street Dam. No other O&M activities or institutional controls would be necessary.

5.5.1 Overall Protection of Human Health and the Environment

Alternative 5 would be an effective long-term remedy for the Allied OU – it would eliminate the potential for direct contact with PCB-containing materials onsite and in the offsite outlying areas, eliminate the potential for human and ecological receptors to be exposed to materials containing PCBs above the relevant PRGs and eliminate the potential for PCB-containing materials to migrate into Portage Creek or onto offsite properties. This would be accomplished through excavation and offsite disposal (with or without immobilization of the excavated materials).

Since no PCBs would be left in place onsite, no monitoring or maintenance activities would be necessary to maintain protectiveness over time. Both total removal sub-alternatives would achieve RAO 1 by mitigating the potential for human and ecological exposure to materials containing PCBs above the relevant PRGs, via excavation and offsite disposal. Implementation of Alternative 5 would also achieve RAO 2, since all materials with PCB concentrations above relevant PRGs would be removed from the OU, thus eliminating the potential for migration to Portage Creek or onto adjacent properties. The removal of all materials with PCB concentrations above the relevant PRGs would eliminate any issues with surface water infiltration and subsurface groundwater migration. Therefore, with respect to RAO 3, this approach would be expected to maintain the current condition in which no groundwater with PCB concentrations exceeding applicable criteria is migrating to the creek or offsite, and there would be no need to further restrict groundwater use. Since all sources of PCBs would be removed, there would be no need for a long-term groundwater monitoring program. Alternative 5 would include a long-term inspection and maintenance program for the Alcott Street Dam.

Achievement of RAO 4 would be challenging. As discussed more under the Short-Term Effectiveness criterion, risks to both onsite workers and the neighboring community associated with the large-scale excavation, handling, transport, and disposal of 1,575,500 cy of PCB-containing materials would be significant, and would have to be effectively managed.

Overall protection of human health and the environment is expected to be achieved upon completion of the excavation and disposal activities (anticipated to take five years for Alternative 5A and six years for Alternative 5B). There would be no need for institutional controls to be put in place to maintain effectiveness over time.

5.5.2 Compliance with Applicable or Relevant and Appropriate Requirements

All the action- and location-specific ARARs that apply to Alternative 4 similarly apply to Alternative 5. As with Alternative 4, all the relevant ARARs would be achieved via the implementation of Alternative 5.

5.5.3 Long-Term Effectiveness and Permanence

The primary process options incorporated into Alternative 5 – excavation, offsite disposal, and immobilization – are proven and reliable, and would be expected to provide long-term protection of human health and the environment after the RAOs have been achieved. After the construction phase is over, all sources of PCBs both onsite and in the offsite outlying areas will be permanently removed. These alternatives would eliminate the potential for PCB-containing materials to migrate via air emissions, wind-blown particles, erosion or surface water runoff into Portage Creek or onto adjacent properties. Stability of the OU and outlying areas would be improved since no PCB-containing materials would be left in place. All excavation areas would be backfilled with clean material, graded to a stable repose, covered with topsoil, and vegetated with native plants and grasses.

There would be no need for institutional controls to restrict access to the OU, and since no PCB-containing materials would remain in place, there would be no need for a long-term monitoring and maintenance program to provide for the long-term effectiveness and permanence of the approach. There is no potential for failure of the remedy over the long term, and there would not likely be a need for restrictions on future use of the OU. The only long-term efforts necessary would be an inspection and maintenance program for the Alcott Street Dam and deed restrictions for the areas beneath the existing buildings on the Goodwill property to prevent actions that might result in direct contact with soils under those buildings.

Although Alternative 5 does not include active remediation of groundwater, since all PCB-containing materials would be removed there would be no need to continue the groundwater monitoring program, and the potential for groundwater with PCB concentrations exceeding applicable criteria to migrate to Portage Creek or offsite would be eliminated.

This alternative also includes the removal of the existing sheetpile along the western bank of Portage Creek. As a result, there would be no risk of failure of the sheetpile or need for maintenance.

This alternative would effectively eliminate OU-related risks over the long term.

5.5.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The immobilization component of Alternative 5B addresses the federal statutory preference for a remedy that employs treatment technologies that permanently and significantly reduce the mobility, toxicity, or volume of PCB-containing materials through treatment. PCBs tend to be relatively immobile in the environment, but adding a stabilizing/binding agent like cement kiln dust (or other suitable agent) after excavation but before offsite disposal to bind the PCBs into a monolith would effectively eliminate the mobility of PCBs in the excavated materials through treatment. However, while the volume of PCB-containing materials onsite and in the offsite outlying areas would be reduced via excavation, adding the stabilizing/binding agent would add approximately 6% to the total volume of materials transported offsite for disposal, which is contrary to the goal of volume reduction

Alternative 5A does not include the extra handling associated with 5B (in 5A the excavated materials would be processed only enough to remove free liquids to pass the USEPA paint filter test prior to offsite transportation and disposal), and therefore does not address the federal statutory preference for a remedy that employs treatment technologies that permanently and significantly reduce the mobility, toxicity, or volume of PCB-containing materials through treatment. However, the volume of PCB-containing material onsite and in the offsite outlying areas would be reduced through the excavation and offsite disposal of approximately 1,575,500 cy of materials.

5.5.5 Short-Term Effectiveness

Implementation of Alternative 5 would present significant short-term risks due to issues associated with health risks to onsite workers, impacts to the community, duration of the project, and environmental impacts.

The potential health risks to onsite remediation workers are due to short-term increases in PCB exposure during site preparation and implementation (a result of either direct exposure or via dust-borne releases during excavation and handling of impacted materials). While this risk could be mitigated through the use of appropriate health and safety practices and by compliance with a Health and Safety Plan, the sheer volume of materials to be handled (1,575,500 cy) and the area of disturbance (a total of 65 acres) significantly increase the chances of exposure. In addition, the number of work hours spent onsite around heavy equipment would be significant over a five to six year project, increasing the risk of an accident as compared to an option where fewer hours are spent in active construction activities. As presented in Attachment 6, an estimated 85,000 worker-hours are required to complete Alternative 5. Based on the estimated worker-hours and general accident statistics from the United States Department of Labor (USDOL), the estimated risk of at least one worker fatality associated with implementation of this alternative is less than 1%. There is a nearly 100% chance that at least one illness or injury would occur during implementation of Alternative 5.

The more significant short-term considerations associated with Alternative 5 are related to impacts to the community and the duration of those impacts – implementation is expected to take five years for Alternative 5A, and six years for Alternative 5B. There will be noise and increased traffic during implementation as well as potentially significant wear and tear on local roads. In addition, down-wind areas such as the residential properties may be subject to an increased potential for dust-borne releases. Excavation work is not confined to the warmer months, so excavation will be carried out year round, five days a week. Over the course of the project, an average of between 30 and 40 trucks per day would travel in and out of the OU over a 260 day work year (five work days per week) to transport excavated material for offsite disposal and haul clean fill to the excavated areas. An estimated 114,000 truck trips to and from the OU would be necessary to implement Alternative 5A compared to 120,000 for Alternative 5B.

As presented in Attachment 6, the offsite disposal component of Alternative 5A would require truck drivers to travel nearly 6,600,000 miles, while the travel associated with Alternative 5B would be nearly 7,000,000 miles. Based on an evaluation of national traffic accident data from the National Highway Transportation Safety Administration (NHTSA), there is an approximately 13% chance (1 in 7) of at least one transportation-related fatality and an estimated 90% chance

(9 in 10) of at least one transportation-related injury occurring during implementation of either variation of Alternative 5.

There would be short-term environmental impacts associated with the potential for offsite migration due to dust-borne releases or incidental releases to Portage Creek given that 65 acres will be disturbed during the implementation of Alternative 5A or 5B. The dust-borne releases could be readily mitigated by keeping the excavation/consolidation areas/materials appropriately wet, but the sheer size of the area being disturbed increases the risk nonetheless. Reasonable and appropriate controls (e.g., silt curtains) would be implemented when removing materials that lie close to Portage Creek and wetland areas of the Panelyte Marsh and Former Monarch Raceway Channel to mitigate impacts to these environments.

The removal of PCB-containing materials beneath the Alcott Street and Goodwill parking lots would cause short-term impacts to neighboring properties/property owners. The excavations at these locations may reach 20 feet or more below grade, and are expected to require benching and/or sheetpile to allow removal to target depths. The installation and removal of sheetpile will create noise and cause vibrations in the immediate area during the period of construction, potentially disturbing nearby property owners/occupants.

Areas disturbed during implementation would be restored after construction with appropriate native plantings (or restored as wetland areas, if appropriate), and the habitat in the impacted areas would be expected to recover quickly.

5.5.6 Implementability

Implementation of Alternative 5 includes the following major components: excavation, immobilization (for Alternative 5B), offsite disposal, and restoration. All the process options incorporated into this alternative are proven and have been used successfully in numerous other environmental cleanup projects. Complete removal of all materials containing PCBs above the relevant PRGs is proven to be reliable.

The disposal of PCB-containing materials in a licensed disposal facility would likely present significant administrative challenges. Based on recent experience with large-scale removal projects in the area, it is apparent that there are only a limited number of solid waste landfills in southwest Michigan that are available to accept PCB-containing materials, regardless of whether those materials meet solid waste regulatory requirements. Where disposal facilities are available, they may have restrictions as to the rate at which they will accept waste material given the limitations of the size and configuration of their operations. Further, among the available solid waste facilities there may be limited disposal capacity to place the PCB-containing materials. The TCRA completed at the former Plainwell Impoundment in Plainwell, Michigan between 2007 and 2009 included the removal and offsite disposal of 130,000 cy of PCB-containing soils and sediments at three solid waste landfills in the region – two were used for non-TSCA waste, and the third was used for TSCA waste. At the time of the TCRA, these were the only facilities in Southwest Michigan that would accept the waste (and the nearest landfill that would accept TSCA waste was located in Detroit). Initially just one landfill was identified for the non-TSCA waste, but during the first season of construction, that landfill temporarily stopped accepting waste, and removal activities were sometimes slowed and occasionally stopped while another landfill was identified and arrangements were made at the original facility to accommodate additional waste. The potential for restrictions in rate and capacity of waste disposal may significantly affect the timely completion of Alternative 5, given the large volume of material that would be disposed offsite. It is also possible that there is insufficient collective disposal capacity at the nearby solid waste facilities and TSCA landfills for the 1,575,500 cy of PCB material contemplated for disposal. In that case, facilities outside of southwest Michigan would have to be considered. This would increase short-term risks since transport distances would be longer.

This alternative could be completed in five to six years assuming offsite disposal does not become a rate-limiting factor.

Excavation, immobilization, and offsite disposal are implementable using readily available, conventional earth-moving equipment. The quantity of materials targeted for excavation and immobilization (1,575,500 cy) is significant.

As described for Alternatives 3 and 4, the excavation of targeted offsite outlying areas is more complicated than the work proposed for the onsite areas, particularly given that parking lots will have to be removed to access soils in certain areas and buildings are in close proximity to the areas targeted for action. Excavations in these areas could extend as deep as 15 to 20 feet below the ground surface. Given this depth and the adjacent buildings, the excavations would need to be stabilized with temporary steel sheeting. Special implementation methods will also be required to drive the sheets while minimizing the potential for damage to the adjacent structure (e.g., trenching and pre-drilling, pile driving using low vibratory methods, crack, vibration, and settlement monitoring).

In addition, excavating to a depth of 15 to 20 feet below the ground surface significantly increases the likelihood of encountering groundwater – as a result, the same supplemental engineering controls described in the implementability section for Alternative 3 would be necessary in Alternatives 5A and 5B to manage groundwater in the saturated fill. While these groundwater management measures will present additional design and construction challenges, they are technically feasible and implementable.

For the immobilization component of Alternative 5B, approximately 6% Portland cement would be added to the excavated materials to immobilize them prior to offsite disposal (the 6% cement ratio is an estimate that would need to be evaluated during the design phase – geotechnical testing would be necessary to assess moisture content, grain size, and other relevant properties of the targeted materials). This addition would dry the soils (by removing free liquids) and harden them to a low-strength concrete similar to a flowable fill that would subsequently harden. The materials would have to be broken up as part of the load-out process at the disposal location.

The necessary services and construction materials are expected to be readily available, and qualified commercial contractors with experience at other Kalamazoo River Superfund Site OUs are available locally to perform the work. Given the 5- to 6-year timeframe associated with this alternative, it is possible that onsite management of the project would be transferred at some point during construction, and support staff – both in the field and the office – would also be subject to turnover. While this type of transition is manageable, it is an issue of implementability to consider.

The sheetpile removal element of this alternative would also be a relatively straightforward effort. A local certified welder would be employed to torch-cut the sheetpile to at least two feet below the planned final grade. The necessary support equipment (a crane to hold the steel while it is being cut) is readily available. Offsite transport and disposal of the sheetpile is not anticipated since the steel should be able to be salvaged or sold.

Since the Allied OU is part of a CERCLA site, permits are not required for onsite activities; however, the substantive applicable requirements of federal and state regulations would need to be met.

5.5.7 Cost

Costs for Alternative 5 are associated with the following construction activities: project area preparation, excavation, offsite disposal, immobilization (in Alternative 5B), sheetpile removal, and restoration. The estimated costs associated with the implementation of Alternative 5A and 5B are presented in Tables 5-7 and 5-8, respectively.

For Alternative 5A, the total estimated capital cost of implementation is $212.6 million. Since there is no O&M component, the total estimated 30-year present worth cost associated with implementation of Alternative 5A is $212.6 million.

For Alternative 5B, the total estimated capital cost of implementation is $224.7 million. Since there is no O&M component, the total estimated 30-year present worth cost associated with implementation of Alternative 5A is $224.7 million.

5.6 Alternative 6 – Hazardous Waste Landfill Containment, Sheetpile Removal, Institutional Controls

Alternative 6 includes the excavation of all soil and/or sediment containing PCBs above the relevant PRGs and disposal within a series of hazardous waste landfill containment cells constructed onsite in the locations of the current Former Operational Areas. In this alternative, all materials in the Former Operational Areas; the Bryant HRDL/FRDLs; the areas that lie close to Portage Creek, the targeted portions of Panelyte Marsh, Panelyte Property, and Conrail Property; the offsite outlying areas other than the portion of the Goodwill property covered by buildings; and those areas in the periphery of the Former Operational Areas near adjacent properties would be excavated (see Figure 4-9).

The areas would be excavated sequentially, with materials stockpiled during cell construction. Since the bottom of each disposal cell would need to be a minimum of 10 feet above the water table, after excavation is complete, clean fill would be added to raise the bottom of the cell to the appropriate elevation. The base liner would then be constructed as described in Section 4.6, approximately 75% of the materials excavated from the Former Operational Areas would be placed in the cell, and the final cover system would be constructed. The remaining 25% of the excavated materials (which would be volumetrically displaced by the clean fill, the base liner, and the cover system) would be transported offsite for disposal along with all the materials excavated from the offsite outlying areas. The cells would be revegetated with native plants and grasses.

This approach would also include long-term inspections and maintenance of the Alcott Street Dam and the hazardous waste landfill containment cells, monitoring of landfill gas and groundwater, and institutional controls.

5.6.1 Overall Protection of Human Health and the Environment

Alternative 6 would be an effective long-term remedy for the Allied OU – it would eliminate the potential for direct contact with PCB-containing materials onsite and in the offsite outlying areas, eliminate the potential for human and ecological receptors to be exposed to materials containing PCBs above the relevant PRGs, and eliminate the potential for PCB-containing materials to migrate into Portage Creek or onto offsite properties. This would be accomplished through excavation and onsite disposal in a series of hazardous waste landfill containment cells, long-term monitoring and maintenance, and institutional controls.

Since PCBs would be left in place onsite, implementation of institutional controls and the monitoring and maintenance components of the remedy would be critical to maintaining protectiveness over time. This approach would achieve RAO 1 by mitigating the potential for human and ecological exposure to materials containing PCBs above the relevant PRGs via isolation in the cells (and offsite disposal of materials displaced). Implementation of Alternative 6 would also achieve RAO 2, since all materials with PCB concentrations above relevant PRGs left onsite would be encapsulated, thus eliminating the potential for migration to Portage Creek or onto adjacent properties. The complete liner system would mitigate any issues with surface water infiltration and subsurface groundwater migration (RAO 3); nevertheless, the long-term groundwater monitoring program would be carried out to verify that groundwater conforms to the applicable risk-based standards.

Achievement of RAO 4 would be challenging. As discussed more under the Short-Term Effectiveness criterion, risks to both onsite workers and the neighboring community associated with the large-scale excavation and handling of PCB-containing materials would be significant, and would have to be effectively managed.

The long-term inspection and maintenance program for the Alcott Street Dam and the newly constructed consolidation cells along with the long-term landfill gas monitoring program would further provide for protection of human health and the environment. A contingent groundwater remedy may be implemented if necessary and appropriate to provide additional overall protection.

Overall protection of human health and the environment is expected to be achieved upon completion of the excavation/consolidation/disposal activities (anticipated to take ten years). Institutional controls would require maintenance of the disposal cells, which would provide for long-term protection of human health and environment.

5.6.2 Compliance with Applicable or Relevant and Appropriate Requirements

All the action- and location-specific ARARs that apply to Alternative 4 similarly apply to Alternative 6. All the relevant ARARs would be achieved via the implementation of Alternative 6.

5.6.3 Long-Term Effectiveness and Permanence

The primary process options incorporated into Alternative 6 – excavation, construction of a series of hazardous waste landfill containment cells, consolidation, and offsite disposal – are proven and reliable, and would be expected to provide long-term protection of human health and the environment after the RAOs have been achieved. The disposal cells would be constructed with two impermeable engineered barriers – one above and one below the contained materials. This is a proven and effective method of isolating and eliminating potential contact with PCB-containing materials. The cells would mitigate the potential for PCB-containing materials to migrate via air emissions, wind-blown particles, erosion or surface water runoff, into Portage Creek or onto adjacent properties. Stability of the OU and outlying areas would be improved as the entire property would be graded to a stable repose as part of the construction of the cells.

Implementation of institutional controls and long-term monitoring and maintenance would provide for the long-term effectiveness and permanence of the disposal cells. The potential for failure of the impermeable barriers used to construct the cells is low, as O&M activities would effectively identify future maintenance needs. Future use of the OU and potential long-term issues would be addressed through monitoring and institutional controls, including deed restrictions, signage, and fencing. The details of long-term monitoring and maintenance would be developed during remedial design and compiled into an O&M program.

Alternative 6 does not include active remediation of groundwater; however, implementation of a long-term groundwater monitoring program would confirm that groundwater quality conforms to applicable risk-based standards, and would mitigate the potential for groundwater with PCB concentrations exceeding applicable criteria to migrate to Portage Creek or offsite.

This alternative also includes the removal of the existing sheetpile along the western bank of Portage Creek. As a result, there would be no risk of failure of the sheetpile or need for maintenance.

This alternative would effectively reduce risks over the long term, and the monitoring components and institutional controls would provide mechanisms to verify the remedy is performing as anticipated over time. If determined necessary, a contingent groundwater remedy may be implemented in conjunction with Alternative 6.

5.6.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 6 does not address the federal statutory preference for a remedy that employs treatment technologies that permanently and significantly reduce the mobility, toxicity, or volume of PCB-containing materials through treatment.

As described under Alternative 2, treatment is most important for constituents of concern that are mobile in the environment. PCBs tend to be relatively immobile in the environment, and at the Allied OU are most prone to migration where they are exposed to erosion. Therefore, the construction of the hazardous waste landfill containment cells would reduce PCB mobility and exposure potential via isolation. The toxicity of the material would not be changed. Since approximately 25% of the materials would have to be disposed offsite, the volume of PCB-containing materials at the OU would also be reduced.

5.6.5 Short-Term Effectiveness

There are significant short-term risks associated with the implementation of Alternative 6. Although the potential health risks to onsite remediation workers due to short-term increases in PCB exposure during site preparation and implementation (a result of either direct exposure or via dust-borne releases during excavation and handling of impacted materials), could be mitigated through the use of appropriate health and safety practices and by compliance with a Health and Safety Plan, the sheer mass of materials to be handled (1,575,500 cy) and the area of disturbance (a total of 65 acres) significantly increase the chances of exposure.

The number of work hours spent onsite around heavy equipment would be significant over a ten year project, increasing the risk of an accident as compared to an option where fewer hours are spent in active construction activities. As presented in Attachment 6, an estimated 350,000 worker-hours is required to complete Alternative 6. Based on the estimated worker-hours and general accident statistics from the USDOL, the estimated risk of at least one worker fatality associated with implementation of this alternative is approximately 4%. There is a nearly 100% chance that at least one illness or injury would occur during implementation of Alternative 6.

Implementation of Alternative 6 would impact the community for a long time – due to the volume of material to be handled, excavation and cell construction are expected to take ten years. There will be noise impacts, the potential for dust-borne releases, increased traffic, and significant wear and tear on local roads during implementation. Excavation work is not confined to the warmer months, so excavation work would be carried out year round, five days a week. Cell construction would be restricted to the Michigan construction season, which is typically late March or early April through the end of October, depending on weather. Over the course of the project, more than 127,000 truck trips would be necessary to transport excavated material from the offsite outlying areas to the onsite disposal cells, to bring in clean fill, and to haul displaced materials to offsite disposal locations. During the approximately six years of the project where excavation and filling work would be the focus, there would be an average of 40 trucks per day in and out of the OU.

As presented in Attachment 6, the offsite disposal component of Alternative 6 would require truck drivers to travel nearly 2,000,000 miles. Based on an evaluation of national traffic accident data from the National Highway Transportation Safety Administration (NHTSA), there is an approximately 4% chance (1 in 24) of at least one transportation-related fatality and an estimated 52% chance (1 in 2) of at least one transportation-related injury occurring during implementation of Alternative 6.

There would be short-term environmental impacts associated with the potential for offsite migration due to dust-borne releases or incidental releases to Portage Creek given that 65 acres will be disturbed during the implementation of Alternative 6. The dust-borne releases could be readily mitigated by keeping the excavation/consolidation areas/materials appropriately wet, but the sheer size of the area being disturbed increases the risk nonetheless. Reasonable and appropriate controls (e.g., silt curtains) would be implemented when removing materials that lie close to Portage Creek and wetland areas of the Panelyte Marsh and Former Monarch Raceway Channel to mitigate impacts to these environments.

The removal of PCB-containing materials beneath the Alcott Street and Goodwill parking lots would cause short-term impacts to neighboring properties/property owners. The excavations at these locations may reach 15 to 20 feet or more below grade, and are expected to require benching and/or sheetpile to allow removal to target depths. The installation and removal of sheetpile will create noise and cause vibrations in the immediate area during the period of construction, potentially disturbing nearby property owners/occupants.

Areas disturbed during implementation would be restored after construction with appropriate native plantings (or restored as wetland areas, if appropriate), and the habitat in the impacted areas would be expected to recover quickly.

5.6.6 Implementability

All the major components of Alternative 6 are proven, readily implementable, and expected to be reliable over long time scales. Administratively, this approach is implementable, and could be completed in ten years assuming offsite disposal does not become a rate-limiting factor (described below).

From a technical perspective, Alternative 6 implementable using readily available, conventional earth-moving equipment. The necessary services and construction materials are expected to be readily available, and qualified commercial contractors with experience at other Kalamazoo River Superfund Site operable units are available locally to perform the work. Given the 10-year time frame associated with this alternative, it is possible that onsite management of the project would be transferred at some point during construction, and support staff – both in the field and the office – would also be subject to turnover. While this type of transition is manageable, it is an issue of implementability to consider.

The sheetpile removal element of this alternative would also be a relatively straightforward effort. A local certified welder would be employed to torch-cut the steel to at least two feet below the planned final grade. The necessary support equipment (a crane to hold the steel while it is being cut) is readily available. Offsite transport and disposal of the sheetpile is not anticipated since the steel should be able to be salvaged or sold.

The key issues with Alternative 6 are related to sequencing, space constraints, and landfill capacity. Given the quantity of materials targeted for excavation and disposal in the hazardous waste landfill containment cells, the project would have to be carried out in phases. In each phase of the onsite work, soils from a particular area would have to be removed, temporarily staged to allow for construction of the base liner, and replaced in the cell. Then the cover system would be installed, and the crew would move on to the next area. As introduced in Section 4.6, the logistical issues associated with implementation of Alternative 6 could likely be complicated, and the complexity of the operation would increase as the project progresses. Soils would be excavated from one area, and temporarily staged in another while clean fill is brought in to establish the base elevation and the base liner is constructed. Then approximately 75% of the soils from the Former Operational Areas would be placed/ graded/compacted in the cell and the final cover would be constructed.

Approximately 25% of the soils targeted for excavation and re-emplacement in the Former Operational Areas and all of the soils excavated from the offsite outlying areas would be volumetrically displaced, which means that more than 460,000 cy of materials would have to be transported offsite for disposal. As described in the implementability discussion for Alternative 5, identifying a landfill or landfills in southwest Michigan able to take that quantity of materials is by no means assured. Even if appropriate disposal facilities are identified, the landfill capacity and other needs/restrictions (i.e., no PCB-containing materials placed at the bottom of a disposal cell or near the leachate collection/drainage system) could limit the rate at which materials could be hauled offsite. If sufficient capacity in southwest Michigan is not available, facilities across a larger area would have to be considered. This would increase short-term risks since transport distances would be longer. Collectively, all these factors would potentially increase the implementation timeframe.

Similar implementability issues as described in earlier alternatives would be encountered in the targeted offsite outlying areas located underneath existing parking lots. These excavations would need to be stabilized with temporary steel sheeting, and special implementation methods would be required to drive the sheets while minimizing the potential for damage to the adjacent structure. In addition, the same supplemental engineering controls described in the implementability section for Alternative 3 would be necessary in Alternative 6 to manage groundwater in the saturated fill. While these groundwater management measures will present additional design and construction challenges, they are technically feasible and implementable.

Since the Allied OU is part of a CERCLA site, permits are not required for onsite activities; however, the substantive applicable requirements of federal and state regulations would need to be met.

5.6.7 Cost

Costs for Alternative 6 are associated with the following construction activities: project area preparation, excavation, installation/construction of the hazardous waste landfill disposal cells, offsite disposal, sheetpile removal, and restoration. The estimated costs associated with the implementation of Alternative 6 are presented in Table 5-9.

For Alternative 6, the total estimated capital cost of implementation is $148.1 million, and the total estimated O&M cost is $4.3 million. The total estimated 30-year present worth cost associated with implementation of Alternative 6 is $152.4 million.

6. Comparative Analysis of Remedial Alternatives

In Section 5, each of the remedial alternatives for the OU was evaluated in detail with respect to seven of the nine CERCLA criteria (as described earlier, the other two criteria – State and community acceptance – are addressed in the ROD by USEPA once formal comments on the FS Report and the proposed plan have been received and a final remedy selection decision is being made). In this section, a comparative analysis of all the remedial alternatives is conducted with respect to each of the seven criteria.

On a comparative basis, each of the following subsections briefly reviews the primary advantages and disadvantages of each alternative with regard to the seven criteria. As described in USEPA guidance (1988), “The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs the decision maker must balance can be identified.”

6.1 Overall Protection of Human Health and the Environment

Alternatives 2, 3, 4, 5, and 6 are all expected to be effective long-term remedies for the Allied OU, all would achieve the four RAOs, and all ARARs would be met. Alternatives 2 and 3 present the most uncomplicated approaches to addressing risks at the OU, and when considering risks associated with remedy implementation, are likely more protective of human health and the environment than the more active remedies of Alternatives 4, 5, and 6.

As discussed in Section 1.4.2 and 1.6, the potential risk pathways at the Allied OU are associated with PCB transport to Portage Creek or floodplain areas from erosion of exposed PCB material and surface water runoff. By addressing the potential sources of PCBs in soils and residuals onsite and in the outlying areas, the potential exposure pathways that involve groundwater, surface water, sediment, air, and fish will be simultaneously addressed. Consequently, the RAOs focus on mitigating the potential for direct exposure to, and further transport of, PCBs in soils and residual onsite and in outlying areas.

Current conditions at the Allied OU are generally stable relative to the ongoing potential for migration of PCBs. The physicochemical properties of PCBs make them relatively immobile in the environment, tending to adhere strongly to organic solids such as those found in paper residuals, and having a low solubility in water. Consistent with their fate and transport properties, PCBs in groundwater and seep samples were detected above PRGs at only 3 of 57 groundwater sampling locations and 2 of 20 seep sampling locations, all in areas of the site that were not addressed by IRM activities. With onsite measured average permeability values of 10^{-7} cm/sec, the residuals meet the permeability requirements for solid waste landfill liners.

The impermeability of the residuals also serves to limit the flux of groundwater through the PCB materials.

In addition, the TCRA and IRMs have addressed contaminated sediments and soils within the Former Bryant Mill Pond area, and the Bryant HRDL/FRDLs are covered with an impermeable cap that essentially eliminates infiltration of water into the underlying PCB material. The existing cap and sheetpile can readily be maintained, and are expected to be effective in the long term for the intended purpose of isolating PCB material from direct contact or migration to other media. An extensive groundwater monitoring network exists with which to confirm the continued protectiveness of these measures. The alternatives presented in this FS were developed to address the remaining source areas to provide a measure of overall protection beyond what has already been achieved via implementation of the TCRA and IRM.

Each of the active alternatives is expected to provide an acceptable level of protection to human health and the environment by physically isolating the PCB material onsite (Alternatives 2, 3, 4), transporting and disposing the material offsite (Alternative 5), or a combination of onsite physical isolation and offsite disposal (Alternative 6). The implication of the large-scale earthmoving activities considered under Alternatives 5 and 6 is that these actions are required to adequately mitigate exposure to, or further transport of, PCBs. However, it is these very activities that present the greatest risks associated with these alternatives. Due to the considerably larger volume of PCB material to be managed under Alternatives 5 and 6 relative to Alternatives 2, 3, and 4, there are correspondingly larger risks related to onsite workers who are involved in excavation and material handling, truck drivers who transport materials offsite for disposal and/or import clean materials to the OU for construction of the earthen covers, impermeable landfill caps, or hazardous waste landfill containment cells. Alternatives 5 and 6 also present an increased potential for direct exposure to onsite workers or release to the environment. There is little to differentiate Alternatives 5 and 6 from Alternatives 2, 3, or 4 relative to overall protectiveness to human health and the environment so long as all elements of the remedy – including O&M – are properly maintained. The short-term risks associated with Alternatives 5 and 6 would also last longer as compared to Alternatives 2, 3, and 4 which could all be completed in about two years – Alternative 5 would take five to six years to complete, and Alternative 6 is estimated to take at least 10 years.

The in-place containment remedies described in Alternatives 2 and 3 are the least complicated approaches to addressing the remaining risks at the OU (as described in Section 1.3, significant steps have already been taken to control sources, address risks, and stabilize the OU) – these options would result in effective, long-term remedies that achieve all the RAOs in a relatively short time frame without the added implementability complications or short-term risks associated with Alternatives 5, 6 and to a lesser degree, 4. The approaches of

Alternatives 2 and 3 also minimize the handling of PCB materials, which is more protective of human health and the environment in the short term than the more active remedies of Alternatives 4, 5, and 6.

In comparison, Alternative 1 would provide no improved protection over the current conditions, provide no risk reduction, and would not be protective of human health or the environment. Alternative 1 would achieve only RAO 4, since there are no risks associated with the No Further Action approach.

6.2 Compliance with Applicable or Relevant and Appropriate Requirements

Although the relevant action- and location-specific ARARs vary among the different alternatives and sub-alternatives (as described throughout Section 5), implementation of each alternative would result in the achievement of the identified ARARs. The only exception is Alternative 1 – the requirements to reduce exposure or associated risk to acceptable levels, achieve an acceptable degree of protectiveness, and appropriately manage/operate disposal areas would not be achieved.

6.3 Long-Term Effectiveness and Permanence

As described at the beginning of Section 5, the key question to consider relative to this criterion is: Does the alternative maintain protection of human health and the environment after RAOs have been met? With the exception of Alternative 1 (which would not achieve RAOs 1, 2, or 3), implementation of any of the other alternatives considered in this FS Report would be expected to be effective over the long term, and provide/maintain protection of human health and the environment after the RAOs have been achieved. All the active alternatives (Alternatives 2-6) are combinations of process options that are proven and reliable, and the potential for failure of any individual component is low.

Alternatives 2, 3, and 4 would take full advantage of and expand upon the IRMs taken to date, achieving long-term effectiveness through onsite containment of the PCB material as a primary component of the remedy, with O&M and institutional controls to verify the permanence of the remedy. Alternative 5 would achieve long-term effectiveness and permanence by removing all PCB material from the OU and disposing of it at offsite solid waste landfills and TSCA facilities. Alternative 6 would achieve long-term effectiveness and permanence by placing the PCB material into hazardous waste containment cells constructed onsite, and by transporting excess PCB material offsite for disposal at solid waste landfills, with long-term monitoring and institutional controls.

Since all materials with PCB concentrations above relevant PRGs would be excavated and disposed offsite and the sheetpile would be removed in Alternative 5, there would be no need for long-term monitoring or maintenance in any area of the OU other than the Alcott Street Dam. While the large-scale removal and offsite disposal of PCB materials contemplated in Alternatives 5 and 6 would seem to provide an added degree of permanence relative to the in-place containment remedies of Alternatives 2, 3, and 4, the perceived protectiveness does not take into account the highly impermeable nature of the residuals and the relative immobility of PCBs. The impermeability of residuals and relative immobility of PCBs make it difficult to identify an advantage for Alternatives 5 or 6 on basis of the potential for transport of PCBs via groundwater. The RI data also indicate that PCB concentrations in groundwater and seeps are generally in compliance with the relevant PRGs across the OU, and only exceed PRGs in those areas in which protective measures had not been taken at the time of sampling. Moreover, the long-term monitoring and maintenance components to be implemented in conjunction with institutional controls under Alternatives 2, 3, or 4 would provide the necessary mechanisms to verify that each remedy is performing as anticipated over time. As a result, Alternatives 2, 3, 4, and 6 are also expected to provide effective, permanent remedies.

6.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Of the range of alternatives considered in this FS, only Alternative 5B directly addresses the statutory preference for a remedy that employs treatment technologies that permanently and significantly reduce the mobility, toxicity, or volume of PCB-containing materials through treatment.

Although treatment of the PCB-containing materials using a stabilizing/binding agent (like cement kiln dust or another suitable agent) would be mixed in with the PCB material as part of Alternative 5B to bind it into a monolith and further reduce the mobility of PCBs via treatment prior to disposal, this approach would add approximately 6% to the total volume of PCB-containing materials, which is contrary to the goal of reducing volume.

Treatment of materials is most important for constituents of concern that are mobile in the environment. However, as discussed elsewhere in this report, PCBs are relatively immobile in the environment. This is especially true at the Allied OU, where they are bound to the highly organic and impermeable paper residuals. As a result, treatment by stabilizing the excavated materials is not expected to significantly reduce the mobility of PCBs at the Allied OU, because they are already relatively immobile.

Alternatives 2A, 2B, 3A, 3B, 4A, 4B, 5A, and 6 all would reduce the mobility of PCBs onsite via isolation and/or containment, and the offsite disposal components of Alternatives 4A, 4B, 5A, 5B, and 6 would reduce the volume of PCB-containing materials at the OU (by varying amounts), but these benefits would not be achieved via treatment. Alternative 1 does not address this criterion. None of the alternatives includes a component that would result in a reduction of the toxicity of PCBs via treatment.

6.5 Short-Term Effectiveness

Considerations associated with the short-term effectiveness criterion are directly related to the area and volume of PCB-containing materials addressed in each alternative, the length of time necessary to implement the remedy, potential risks to workers, and potential impacts to the community during construction. Short-term effectiveness issues, which are discussed in detail in the Section 5, are summarized in Table 6-1, below.

Table 6-1
Summary of Short-Term Effectiveness Considerations

Alternative	Total Area Addressed	Total Volume of PCB-Containing Materials Addressed	Duration	Worker Risks	Community Impacts
Alternative 2	2A: 39 acres 2B: 39 acres	2A: 225,000 cy 2B: 265,500 cy	2 years	Minimal, managed via Health and Safety Plan	Minimal, associated with dust, noise, truck traffic (11,000 truck trips for 2A; 13,000 truck trips for 2B)
Alternative 3	3A: 39 acres 3B: 42 acres	3A: 225,000 cy 3B: 316,000 cy	2 years	Minimal, managed via Health and Safety Plan	Minimal, associated with dust, noise, truck traffic (17,000 truck trips for 3A; 22,000 truck trips for 3B)
Alternative 4	4A: 39 acres 4B: 42 acres	4A: 265,500 cy 4B: 316,000 cy	2 years	Minimal, managed via Health and Safety Plan	Minimal to moderate, associated with dust, noise, and truck traffic particularly with longer routes for offsite disposal (22,000 truck trips for 4A; 28,000 truck trips for 4B)
Alternative 5	65 acres	1,575,500 cy	5-6 years	Significant given the area/volume of targeted material and increased project duration.	Significant, associated with noise, dust, and particularly increased truck traffic, which would average 40 trips daily in and out of the OU for the duration of the project (114,000 truck trips for 5A; 120,000 truck trips for 5B)
Alternative 6	65 acres	1,575,500 cy	10 years	Significant given the area/volume of targeted material and significantly increased project duration	Significant, associated with noise, dust, and particularly increased truck traffic, which would average 40 trips daily in and out of the OU for the duration of the project (127,000 truck trips);

All the alternatives with active remedial components would have some short-term impacts associated with increased noise from construction vehicles, the potential for dust-borne releases, increased traffic around the OU, increased wear and tear on local roads, increased potential for workers to come in contact with PCB-containing materials, and other risks associated with construction work. For Alternatives 2, 3, and 4, these impacts would be minimal and effectively addressed through implementing a project-specific Health and Safety Plan, keeping excavation areas properly wetted, planning truck routes to minimize disturbances to the surrounding community, and other standard practices.

The two alternatives that present the most significant short-term impacts are Alternatives 5 and 6. The project duration for these alternatives is longer than Alternatives 2, 3, and 4 – the duration of Alternative 5 is nearly three times longer, and Alternative 6 is five times longer. Over these extended time frames, risks to workers increase. Given occupational injury statistics from the USDOL, it is estimated that the risk of injury to onsite workers approaches 1 in 1 for Alternatives 5 and 6, and the risk of a worker fatality is approximately 1 in 100 for Alternative 5 and approximately 1 in 25 for Alternative 6.

In addition, the sheer volume of materials to be handled in Alternative 5 and 6 equate to a significant increase in truck traffic in to and out of the OU. In Alternative 5, there would be an average of 40 trips per day, year round, for the 5 to 6 years of the project, and during the approximately 6 years of Alternative 6 where excavation and filling work will be the focus, there would be an average of 40 trips per day into and out of the OU. This increase in truck traffic leads to an increased risk for vehicular accidents. Based on data from the NHTSA, there is an approximately 90% chance that there would be at least one transportation-related injury and an approximately 13% chance of a fatal accident under Alternative 5. There is an approximately 4% chance of a fatal accident and an approximately 52% chance of a transportation-related accident associated with implementation of Alternative 6.

In addition to these quantitative impacts, there are also more qualitative impacts to the local community, such as noise, dust, and traffic over local roads for a period of 6 years (Alternative 5) to 10 years (Alternative 6), which will place a significant burden on the community.

There are no short-term impacts associated with construction or implementation for Alternative 1; however, since existing measures in place to control access to the OU would not be maintained, there could be an increased risk of direct exposure over the short-term to individuals who trespass and come into contact with surficial materials containing PCBs.

6.6 Implementability

Most of the major components of Alternatives 2, 3, 4, 5, and 6 are proven, readily implementable, have been used successfully as part of other environmental cleanup projects, and are expected to be reliable over the long term. All the alternatives are administratively implementable, and although no permits would be required, the substantive applicable requirements of federal and state regulations would be met.

In addition, Alternatives 2, 3, 4, 5, and 6 could all be carried out using readily available, conventional earth-moving equipment, and most of the necessary services and construction materials are expected to be readily available. Qualified commercial contractors with experience at other areas of the Kalamazoo River Superfund Site are available locally to perform the work.

The key implementability differences are associated with three activities:

- Excavation work at the targeted offsite outlying areas located underneath existing parking lots that is a component of Alternatives 3B, 4B, 5, and 6.
- Availability of solid waste and/or TSCA landfills to accept the volume of materials to be disposed offsite in Alternatives 4, 5, and 6 at the rate they would be generated.
- Limited staging area and construction of the hazardous waste landfill containment cells in Alternative 6.

Excavation work. As described in Section 5, the excavation of materials underneath the existing parking lots as part of Alternatives 3B, 4B, 5, and 6 would be much more difficult in comparison to the work contemplated in those areas in Alternatives 2A, 2B, 3A, and 4A. The excavation depths in the parking lot areas could extend as deep as 15 to 20 feet below the ground surface, and as a result, the excavations would have to be stabilized with temporary steel sheeting. Special implementation methods would be required to advance the steel sheets due to the proximity of existing buildings.

Further, excavating to a depth of 15 to 20 feet below the ground surface significantly increases the likelihood of encountering groundwater – as a result, supplemental engineering controls (including a combination of excavation reinforcement via sheeting, dewatering, and soil stabilization) would be necessary in Alternatives 3B, 4B, 5, and 6 to manage groundwater in the saturated fill. Additional engineering controls may be necessary to deal with hydrostatic pressure at the base of the excavation.

While these issues associated with completing the deep excavations as part of Alternatives 3B, 4B, 5, and 6 can be addressed using technically feasible and implementable engineering approaches, none of these additional implementability challenges would have to be considered in the design or construction of Alternatives 2A, 2B, 3A, or 4A.

Landfill availability. As discussed in Section 5.5.6, there are few solid waste landfills in southwest Michigan that are available to accept PCB-containing material, regardless of whether that material meets solid waste regulatory requirements. These facilities commonly have limits on disposal capacity and disposal rates that may significantly affect the timely completion of Alternatives 4, 5, or 6, in which a large volume of PCB-containing material would be disposed offsite. It is also possible that the combined disposal capacity in all of the nearby solid waste facilities and TSCA landfills would be insufficient for the large volumes of PCB material contemplated for disposal under Alternatives 4, 5, and 6, which may result in increased transport distances for offsite disposal, and consequentially increased risks and costs.

Construction of the hazardous waste landfill containment cells. The additional implementability challenges associated with the construction of the hazardous waste landfill containment cells in Alternative 6 are described in Section 5..6, and are primarily associated with sequencing and space constraints. Developing a plan for excavating 1,575,500 cy of PCB-containing materials, constructing the full-encapsulation disposal cells, and re-emplacing the excavated materials in the cells presents challenges and issues that would not need to be contemplated for any other alternative. As each hazardous waste disposal cell is sequentially constructed, a successively smaller area will be available onsite for staging of clean materials and temporary storage of PCB-containing materials. Eventually onsite capacity will be depleted, and a substantial volume of material will have to be disposed offsite. Approximately 25% of the soils targeted for excavation and re-emplacement in the Former Operational Areas and all of the soils excavated from the offsite outlying areas would be volumetrically displaced, which means that more than 460,000 cy of materials would have to be transported offsite for disposal – this has a significant impact on both the implementation and cost of this alternative. The control and management of surface water runoff from the temporarily stored PCB-containing materials also will become increasingly challenging over time as less area is available for these operations under Alternative 6.

There may be local community resistance to the trucks transporting PCB materials from the site over local roads en route to offsite disposal facilities, especially under Alternatives 5 and 6 in which such activities would extend from 5 to 10 years in duration, respectively. In addition, given the 10-year time frame associated with Alternative 6 and the 5- to 6-year timeframe associated with Alternative 5, it is possible that onsite management of the project would be transferred at some point during construction, and support staff – both in the field and the office

– would also be subject to turnover. While these types of transitions are manageable, they are not issues that are likely to impact Alternatives 2, 3, or 4 given their shorter durations.

There are no technical or administrative implementability issues associated with Alternative 1 since no active remediation would take place.

6.7 Cost

The costs for the range of alternatives and sub-alternatives presented in this FS are summarized in Table 6-2 (below), and the detailed estimates and associated assumptions are presented in Tables 5-1 through 5-9. The cost estimates are consistent with FS level of estimation, with an accuracy of +50% to -30%. A final cost estimate would be developed and refined during the remedial design process after the selection of a recommended remedy.

As shown below, Alternative 1 has no associated costs since there would be no further actions taken. Alternatives 2A and 2B are estimated to cost $18.6 and $19.9 million, respectively. Incorporation of the impermeable landfill cap in Alternatives 3A and 3B increases the costs relative to Alternatives 2A and 2B by $5.6 and $10 million, respectively. At $27.8 million Alternative 4A is in the same general range as Alternatives 3A and 3B, but the offsite disposal component of Alternative 4B drives up the cost of that option to $35.6 million. Significant increases in the volumes of materials handled and disposed offsite in Alternatives 5A and 5B result in costs of more than $200 million for the total removal options. The hazardous waste landfill containment approach described for Alternative 6 would cost an estimated $152.4 million.

Table 6-2
Summary of Remedial Alternative Costs

Alternative	Estimated Capital Cost	Estimated O&M Cost	Total Present Worth Cost
Alternative 1	$0	$0	$0
Alternative 2A	$14.3 M	$4.3 M	$18.6 M
Alternative 2B	$15.6 M	$4.3 M	$19.9 M
Alternative 3A	$19.9 M	$4.3 M	$24.2 M
Alternative 3B	$25.6 M	$4.3 M	$29.9 M
Alternative 4A	$23.5 M	$4.3 M	$27.8 M
Alternative 4B	$31.3 M	$4.3 M	$35.6 M
Alternative 5A	$212.6 M	$0	$212.6 M
Alternative 5B	$224.7 M	$0	$224.7 M
Alternative 6	$148.1 M	$4.3 M	$152.4 M

Note: All costs are based on 2009 dollars; $ M = million dollars.

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TABLES

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Table 2-2 – Federal, State, and Local Action- and Location-Specific ARARs and TBCs

Regulation	Citation	Description	ARAR/TBC	Rationale
FEDERAL				
Toxic Substances Control Act	40 CFR 761	Provides regulations for storage and disposal of materials containing PCBs greater than 50 mg/kg. Applicable to PCB-containing materials which were disposed after 1978.	TBC	Residuals containing greater than 50 mg/kg PCBs were disposed prior to 1978.
Clean Water Act	40 CFR 230	Guidelines to restore and maintain the chemical, physical, and biological integrity of waters of the United States by controlling discharge of fill material.	TBC	Guidelines may be followed for placement (or disposal) of fill into the river, floodplain, or wetland.
	40 CFR 232	Requirements for placement of fill	ARAR	Substantive requirements of Section 404 permit must be met.
	40 CFR 122 40 CFR 125 40 CFR 136 40 CFR 1341, 1344	Establishes site-specific pollutant limitations and performance standards which are designed to protect surface water quality. Types of discharges regulated under the CWA include: discharge to surface water (including stormwater), direct discharge to a POTW, and discharge of dredged or fill material into United States waters.	ARAR	May be relevant and appropriate for remediation alternatives which treat and/or discharge water. Relevant and Appropriate for stormwater. Regarding stormwater regulations, the USEPA Region V Construction General Permit outlines a set of provisions to follow. State standards that are more restrictive than federal criteria become the relevant and appropriate requirement, consistent with CERCLA 121(d).
	40 CFR 129	Establishes effluent standards for toxic compounds including PCBs (40 CFR 129.105). Applies to discharges to navigable waters.	ARAR	Applicable for remedial alternatives that would include discharge of water to Portage Creek.
Rivers & Harbors Act	33 USC 403 33 CFR 322 33 CFR 323	Prohibits unauthorized obstruction or alteration of any navigable waters (filling, cofferdams, piers, etc.)	ARAR	Remedial activities may be conducted in such a way as to avoid obstruction or alteration to Portage Creek channel.

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Table 2-2 – Federal, State, and Local Action- and Location-Specific ARARs and TBCs

Regulation	Citation	Description	ARAR/TBC	Rationale
Executive Orders: 11990 – Protection of Wetlands 11988 – Floodplain Management	40 CFR 6.302 40 CFR 6, Appendix A; OSWER 9280.0-03	Requires federal agencies, where possible, to avoid or minimize adverse impacts of federal actions upon wetlands/floodplains. Calls for agencies to preserve and restore floodplains so that their natural and beneficial values can be realized.	ARAR	Executive orders affect any work conducted in floodplains or wetlands.
Fish and Wildlife Coordination Act	16 USC 661-667e 33 CFR 320 – 330 40 CFR 6.304	Protection of endangered species and wildlife.	ARAR	The OU is not known to be a habitat for endangered species or wildlife. A search will be run through the State Historic Preservation Office.
Endangered Species Act	16 USC 1531-1544 50 CFR 200 50 CFR 402	Requires federal agencies to ensure that the continued existence of any endangered or threatened species and their habitats will not be jeopardized by a site action.	ARAR	There are no known endangered species associated with the OU. A search will be run through the State Historic Preservation Office.
Resource Conservation and Recovery Act (RCRA)	40 CFR 257	Establishes the regulations regarding criteria for classification of solid waste disposal facilities and practices.	ARAR	Applicable if residuals are removed from the OU.
	40 CFR 264.221 40 CFR 264.226 40 CFR 264.227 40 CFR 264.228	Establishes dike stabilization guidelines for surface impoundments containing hazardous materials.	TBC	Although the OU is not a RCRA surface impoundment, dike stabilization criteria may be considered when evaluating remedial alternatives.

See Notes on Page 11.

Table 2-2 – Federal, State, and Local Action- and Location-Specific ARARs and TBCs

Regulation	Citation	Description	ARAR/TBC	Rationale
RCRA Subtitle D – Management of Solid Wastes	40 CFR 257 and 258 42 U.S.C. 6901 et seq.	Establishes standards for the management and disposal of solid waste, including: 1) Facility or practices in floodplains will not restrict the flow of base flood, reduce the temporary water storage capacity of the floodplain, or otherwise result in a washout of solid waste; 2) Facility or practices shall not cause discharge of dredged or fill material into waters of the United States; 3) Facility or practice shall not allow uncontrolled public access so as to expose the public to potential health and safety hazards; 4) Covers groundwater monitoring and corrective action requirements under Subpart E and closure and post closure care under Subpart F.	TBC	May be considered as it offers guidance on management of waste.
Clean Air Act	40 CFR 52 42 U.S.C. 7401 et seq.	Establishes requirements for constituent emission rates in accordance with National Ambient Air Quality Standards.	TBC	May be considered for remedial alternatives that include relocation of residuals. State criteria may also apply.
		Provides valuable guidelines with respect to minimizing the harmful effects of fugitive dust and airborne contaminants that result from excavation, construction, and other removal activities. Establishes primary and secondary ambient air quality standards for emissions of chemicals and particulate matter.	TBC	May be considered for remedial alternatives that include excavation/removal of residual/soil.
Water Quality Standards	40 CFR 264.226	State-specific ARARs for surface water quality.	ARAR	State-specific ARARs may govern where more stringent than federal ARARs

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Table 2-2 – Federal, State, and Local Action- and Location-Specific ARARs and TBCs

Regulation	Citation	Description	ARAR/TBC	Rationale
USDOT Placarding and Handling	40 CFR 264.227 49 CFR 171	Transportation and handling requirements for materials containing PCBs with concentrations of 20 mg/kg or more.	ARAR	This would apply if residuals are removed from the OU.
Occupational Safety and Health Act – Hazardous Waste Operations and Emergency Response	29 CFR 1910.120.	Establishes health and safety requirements for cleanup operations at sites on the National Priorities List.	ARAR	Applies to any action alternative for protection of onsite workers.
Safe Drinking Water Act – Section 1428	42 USC 300h	Wellhead protection	TBC	The OU is within one of the City's 5-year time-of-travel capture zone for a wellfield. Michigan's Wellhead Protection Program is implemented through this regulation.
STATE				
Michigan Public Act 451, Part 303 – Wetlands Protection	MCL 324.30301-30323 MAC 281.921-925	Establishes the rules regarding wetland uses.	ARAR	For certain remedial alternatives these regulations may limit potential work and/or storage areas.
Michigan Public Act 451, Part 201 – Environmental Remediation	MCL 324.20118(2) MCL 324.20120a MAC 299.5705	Requires that a remedial action shall provide for response activity that will satisfy cleanup criteria.	ARAR	The remedial action implemented must meet generic or OU-specific cleanup criteria.
	MCL 324.20120a MAC 299.5708	If the target detection limit or background concentration is greater than the risk-based cleanup criteria, the target detection limit or background concentration shall be used instead of the risk-based cleanup criterion.	ARAR	Applicable to all environmental media and may be used to gauge the success of the remedial action.

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Table 2-2 – Federal, State, and Local Action- and Location-Specific ARARs and TBCs

Regulation	Citation	Description	ARAR/TBC	Rationale
Michigan Public Act 451, Part 201 – Environmental Response (continued)	MCL 324.2017a MCL 324.20114	Requirements for owner of a facility, such as preventing exacerbation and exercising due care.	ARAR	Applicable if existing PCBs are left in place or if there is a release of PCBs from the OU.
	MCL 324.20116 MCL 324.20120a(16) MCL 324.20120b MAC 299.5524	Restrictions on transfer of real property designated as a facility. Requirement that if residential criteria are not met, land use restrictions must be provided. Actions required upon approval of remedial action plans.	ARAR	Due to the presence of PCBs, property cannot be transferred without notification of land use restrictions that apply to the OU. All actions leaving PCBs in place must include deed restrictions on activities that may interfere with the integrity of the remedial action and on activities that may result in unacceptable exposure.
	MCL 324.20118, et al. MAC 299.5532(11)	Required elements of remedial action plans (remedial design documents).	ARAR	Substantive requirements can be met in remedial design documents. For example, by including an aquifer monitoring plan and operation and maintenance plan. Such plans identify points of compliance for judging the effectiveness of the remedial action.
	MCL 324.20120c	Required action if contaminated soil is moved offsite or relocated within the site.	ARAR	Material moved off site must be evaluated to determine if it is subject to the requirements of Part 111 (Hazardous Waste Management). Required approval to move soil can be attained through MDEQ approval of a Remedial Design.
	MAC 299.5520 MAC 299.51003-51005	Objectives of response activities, determination (or nullification) that a response activity is complete.	ARAR	When the response action is complete, the entity initiating the action has the burden of demonstrating that the action meets all requirements.
	MAC 299.5522 MAC 299.51017	Liable parties must provide notice to the department and adjacent land owners in certain situations, such as if hazardous substances emanate beyond the property boundary.	ARAR	Applicable if there is a release (above criteria) from the OU or if GSI criteria are exceeded during/after remedial action.

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Table 2-2 – Federal, State, and Local Action- and Location-Specific ARARs and TBCs

Regulation	Citation	Description	ARAR/TBC	Rationale
Michigan Public Act 451, Part 301 – Inland Lakes and Streams	MCL 324.30101-30113 MAC 281.811-846	Regulates dredging or filling of lake or stream bottoms.	ARAR	For remedial alternatives involving any fill in the river channel or streambeds, activities may be restricted by these regulations.
Michigan Public Act 451, Part 91 - Soil Erosion and Sedimentation Control	MCL 324.9112 MCL 324.9116 MAC 323.1701-1714	Requirements for owners of land undergoing an earth change. Establishes rules prescribing soil erosion and sedimentation control plans, procedures, and measures.	ARAR	For any remedial action involving an earth change, liable parties must implement and maintain soil erosion and sedimentation control measures. Substantive requirements of permit must be satisfied.
Michigan Public Act 451, Part 31 – Water Resources Protection	MCL 324.3112	Prohibits discharging waste or waste effluent into surface water without approval of the State.	ARAR	Certain remedial alternatives may involve discharge of waters to Portage Creek. Substantive requirements of a NPDES permit must be met.
	MCL 324.3109a	Allows for mixing zone for discharge of venting groundwater.	TBC	For any remedial alternative where waste is left in place, the mixing zone criteria shall not be less protective than for point source discharges.
	MCL 324.3109b	Defines when Part 31 remedial obligations are satisfied.	TBC	For any remedial alternative meeting the requirements of Part 201, Part 31 requirements are satisfied.
	MCL 324.3108	Prohibits filling or grading of a floodplain, unless permitted by the State.	ARAR	For alternatives involving excavation below the 100 year flood elevation, substantive requirements of a permit must be satisfied.
	MCL 323.1201-1221 MCL 323.2101-2195	Establishes effluent standards in accordance with federal WPCA and CWA.	ARAR	May be applicable for alternatives involving discharge of water to Portage Creek.
	MCL 232.2204-2207	Establishes the rules regarding water and wastewater discharge provisions for the non-degradation of groundwater quality, and uses of groundwater.	ARAR	May be applicable if remedial alternatives involve discharge of waters or waste to groundwater or the ground.
Michigan Public Act 451, Part 13 – Floodplains and Floodways	MAC 323.1311-1329	Regulates activities to occupy, fill, or grade lands in a floodplain, streambed, or channel of a stream.	ARAR	The OU lies within the 100-year floodplain. Substantive requirements would need to be met for certain remedial activities.

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Table 2-2 – Federal, State, and Local Action- and Location-Specific ARARs and TBCs

Regulation	Citation	Description	ARAR/TBC	Rationale
Michigan Public Act 451, Part 111 – Hazardous Waste Management	MCL 324.11101-11153 MAC 299.9101 -11107	Establishes requirements for hazardous waste generators, transporters, and treatment/storage/disposal facilities.	TBC	Certain portions of the regulations may be useful as a means of determining proper methods of handling/ transportation. Response activities may generate waste residuals that may be classified as hazardous waste. Used for characterizing and identifying hazardous wastes and determining appropriate treatment and disposal.
Michigan Public Act 451, Part 115 – Solid Waste Management	MCL 324.11501-11504 MCL 324.11507 MCL 324.11540 MAC 299.4101-4106a MAC 299.4301 (3)(d)	Establishes rules for methods of solid waste disposal and for design/operational standards for disposal areas. Describes where Type III Landfill standards apply.	ARAR	By statute, the OU is a “disposal area.” By rule, the OU is a “Sanitary Landfill, Type III” to which Type III standards apply.
	MAC 299.4304	Type III final cover design to minimize erosion and infiltration to protect public health.	ARAR	Considering Type III standards apply to the OU, cover design requirements must be met.
	MAC 299.4305 MAC 299.4307 MAC 299.4308	Landfill location restrictions and liner design standards.	TBC	Not applicable because the OU is not a new disposal area. However, location restrictions and liner design standards may be considered for alternatives that include on-site disposal.
	MAC 299.4306	Water quality performance standards.	ARAR	The landfill design must ensure that all requirements for the protection of surface and groundwater under Part 31 (and rules) are met. For example, if the final cover is undermined by a 100-year flood event, this requirement would not be met. A design that keeps the final cover from being inundated is capable of limiting erosion and infiltration to the extent necessary to protect human health and the environment.

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Table 2-2 – Federal, State, and Local Action- and Location-Specific ARARs and TBCs

Regulation	Citation	Description	ARAR/TBC	Rationale
Michigan Public Act 451, Part 115 – Solid Waste Management (continued)	MAC 299.4310	For landfills that do not have a liner or a leachate collection system, The minimum required permanent clearance between waste and groundwater is 4 feet.	ARAR	The landfill does not currently have a liner or leachate collection system. The separation between waste and groundwater is applicable unless (1) a leachate collection system is installed (2) a gravity collection system is installed, or (3) a variance is approved by the MDEQ.
	MAC 299.4318	Type III landfill groundwater monitoring requirements.	ARAR	Substantive requirements must be met by any Remedial Action that leaves PCBs in place.
	MAC 299.4905-4908	Requirements of a hydrogeologic monitoring plan and monitoring network and associated sampling.	ARAR	Substantive requirements must be met by documents submitted during Remedial Design and implemented through Remedial Action.
	MAC 299.4912	Requirements for natural soil barriers.	TBC	Natural soil barriers (or augments) may be evaluated by the specifications in this rule to help determine if the barriers are adequate to prevent lateral flow of groundwater or leachate into and out of the waste.
	MAC 299.4913 MAC 299.4915	Requirements for final cover materials.	ARAR	Covers must meet the specifications in the rules.
	MAC 299.4916-4921	Construction Quality Control Program	ARAR	Substantive portions of construction quality control must be met in Remedial Design and Remedial Action.
Michigan Occupational Safety and Health Act, Act 154 of 1974	MAC 408.1001, et. seq. (Parts 1-49)	Establishes the rules for safety standards in the workplace.	ARAR	Onsite remedial actions have the potential to expose workers to PCBs. Construction, excavation and other actions may present potential health hazards to workers. Human labor could construct remedial systems and provide long-term maintenance on the systems. Such activities are governed by worker safety and health standards under this Act and are applicable to all site actions and activities.

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Table 2-2 – Federal, State, and Local Action- and Location-Specific ARARs and TBCs

Regulation	Citation	Description	ARAR/TBC	Rationale
Michigan Public Act 451, Part 55 - Air Pollution Control	MAC 336.1101-2706	Establishes rules prohibiting the emission of air contaminants in quantities which cause injurious effects to human health, animal life, plant life or significant economic value, and/or property.	ARAR	Applicable for remedial alternatives that would generate air emissions (e.g., dust, during excavation, soil stabilization, or compaction). For certain remedial alternatives, air emissions must comply with substantive requirements of permits and monitoring would be required.
Michigan Public Act 300 of 1949, as amended. Michigan Vehicle Code	MCL 257.716, 257.722, et seq MAC 257.101, et seq	Rules governing the reduction of maximum axle loads during springtime frost periods.	ARAR	Remedial action and construction may require heavy loads of equipment, fill dirt, PCB-containing media, etc. to be transported over roadways; however, this is not allowed during frost periods.
Michigan Public Act 451, Part 365 - Endangered Species Protection	MCL 324.36501 - 36507	Establishes rules to provide for conservation, management, enhancement, and protection of species either endangered or threatened with extinction.	ARAR	There are no known endangered species associated with the OU. A search will be run through the State Historic Preservation Office.
Michigan Public Act 306 of 1969, as amended – Well Construction Code	MCL 24.233, 24.263, and 333.12714	Establishes rules for well installation and abandonment.	ARAR	Applicable to wells that are abandoned or wells that are installed as part of the contingent groundwater remedy.
LOCAL				
Noise	Chapter 21 – Code of the City of Kalamazoo	Secures/promotes the public health, comfort, convenience, safety, and welfare of City residents; promotes peace & quiet.	TBC	Certain remedial alternatives may involve machinery that may exceed noise limits for private property without special considerations.
Soil Erosion and Sedimentation Control	Chapter 30 – Code of the City of Kalamazoo	Control soil erosion and sedimentation with respect to earth change activities within the City.	TBC	For any remedial action involving an earth change, liable parties must implement and maintain soil erosion and sedimentation control measures. Substantive requirements of permit must be satisfied.

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Table 2-2 – Federal, State, and Local Action- and Location-Specific ARARs and TBCs

Regulation	Citation	Description	ARAR/TBC	Rationale
City of Kalamazoo Performance Standards for Groundwater Protection within Wellhead Protection Capture Zones and Stormwater Quality Management	--	Defines technical standards for site development that facilities located within the Capture Zones are required to attain for drinking water source protection and to protect surface water quality by establishing acceptable stormwater quality management strategies throughout the City. Includes best management practices.	TBC	The OU is within one of the City's 5-year time-of-travel capture zones for a well field.
Drinking Water Well Installation	Chapter 19b, Chapter 24b, Chapter 25b, Kalamazoo County Sanitary Code	Prohibits certain uses of groundwater from wells at properties located in the vicinity of such sites that are the source, or location, of Contaminated Groundwater, or where there is a known threat from Contaminated Groundwater.	TBC	The OU is within a restricted zone, prohibiting any drinking well installation within the area.
Groundwater Sites of Concern, Kalamazoo Township, City of Kalamazoo, City of Parchment, Kalamazoo County, Michigan	--	Location of Restricted zones referred to in Kalamazoo County Sanitary Code, Chapter 19b	TBC	The OU is within a restricted zone, prohibiting any drinking well installation within the area.

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Table 2-2 – Federal, State, and Local Action- and Location-Specific ARARs and TBCs

Notes:
Chemical-specific ARARs are not included in this table.

ARAR - Applicable or Relevant and Appropriate Requirements
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
CFR – Code of Federal Regulations
CWA – Clean Water Act
GSI – groundwater surface water interface
MAC - Michigan Association of Counties
MCL - Michigan Compiled Laws
MDEQ – Michigan Department of Environmental Quality
mg/kg – milligrams per kilogram
NPDES - National Pollutant Discharge Elimination System
OU – operable unit
PCBs – polychlorinated biphenyls
POTW - Publicly Owned Treatment Works
RCRA - Resource Conservation and Recovery Act
TBC – to be considered
TSCA - Toxic Substances Control Act
USC - United States Federal Code
USEPA – United States Environmental Protection Agency
USDOT – United States Department of Transportation

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Table 3-1 – Initial Screening of Technologies

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
A. No Further Action				
	No Further Action	**The "no action" technology includes ongoing natural attenuation of PCBs in soils and sediments, but would not require any engineering or institutional controls to mitigate exposure, or monitoring to assess ongoing contact with constituents of concern, and as such serves as a baseline for comparison to all other remedial technologies. Inclusion of this technology is required by the National Contingency Plan.**	**Soils[3], sediments, and groundwater**	**Implementable[4]**
B. Institutional Controls				
	Access Restrictions, Deed Restrictions, and Fish-Consumption Advisories	**Institutional controls (IC) could include legal, administrative, and/or physical controls that mitigate the potential for exposure to constituents of concern in soils, sediments, groundwater and surface water. Examples of potential ICs include proprietary controls (e.g., easements, covenants), governmental controls (e.g., zoning, building codes, groundwater use regulations), enforcement and permit tools with IC components (e.g., orders, permits, consent decrees), informational devices (e.g., state registries, fishing advisories, signs), and access controls (e.g., fencing).**	**Soils, sediments, and groundwater**	**Implementable; access restrictions, deed restrictions, fish-consumption advisories, and fencing are already in place in some areas**
C. Monitoring				
	Monitoring	**Monitoring would involve the collection and analysis of site samples (e.g., soil, sediment and/or groundwater) and/or performance of visual reconnaissance (inspections) to track site conditions.**	**Soils, sediments, and groundwater**	**Implementable**
D. Monitored Natural Attenuation				
	Natural Processes	The effects of ongoing physical, biological, and chemical processes that reduce PCB exposure, toxicity, and mobility would be monitored to verify decreasing concentration trends. The persistence and immobility of PCBs do not support natural degradation of PCBs in soil or groundwater.	Soils, sediments, and groundwater	Implementable, though unproven for soils and groundwater

Notes:
1. Shaded process options are screened out at this step and not retained for further evaluation.
2. **Bolded process options** are the representative process options that have been carried through for the screening evaluation of process options.
3. For the purposes of this screening table, "soils" are considered to also include residuals.

See page 7 for acronyms.

Table 3-1 – Initial Screening of Technologies

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
E. In-Situ Containment				
1. Engineered Barrier	**Engineered Landfill Cap (Earthen Cover)**	**This Process Option includes the grading in place and placement of clean earthen material directly over affected soils/sediments. Earthen cover would indirectly address groundwater by reducing infiltration of precipitation and formation of leachate.**	**Soils, sediments, and groundwater**	**Implementable; equipment, materials, and labor readily available**
	Engineered Landfill Cap (Impermeable Cover System)	**This Process Option involves grading in place of existing soils/sediments and placement of a multi-layered cap (e.g., clean soil, sand, gravel, cobbles, geotextile), including an impermeable layer (e.g., geomembrane, compacted clay) over and around affected sediment and/or soil to isolate constituents and mitigate erosion.**	**Soils, sediments, and groundwater**	**Implementable; cap is already in place in some areas**
	Hazardous Waste Landfill Containment System	**This Process Option involves removing all targeted soils/sediments, temporarily stockpiling all materials, constructing and lining a hazardous waste landfill containment cell, re-emplacing all materials within the lined cell, and constructing an impermeable cover system over the cell to isolate constituents and mitigate erosion.**	**Soils, sediments, and groundwater**	**Implementable**
2. Erosion Control	**Rip Rap, Sheetpile**	**This Process Option prevents erosion (and subsequent transport) of materials by velocity control measures, barrier mechanisms, or re-impoundment of materials.**	**Soils and sediments**	**Implementable; sheetpile is already in place in some areas**
3. Hydraulic Containment	**Groundwater Extraction**	**This Process Option includes installation of recovery wells/trenches and the collection of groundwater in an alignment designed to capture/ contain affected water.**	**Groundwater**	**Implementable**
	Funnel and Gate	This Process Option involves the use of an impermeable flow barrier to divert groundwater flow, may be combined with targeted groundwater removal or reactive gate.	Groundwater	Implementable; though an effective reactive gate for groundwater may not be implementable

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Table 3-1 – Initial Screening of Technologies

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
F. In-Situ Treatment				
1. Biodegradation	Natural, Enhanced	This Process Option involves degradation using microorganisms.	Soils and sediments	This process has not been successfully demonstrated reliably to achieve target concentrations for PCBs for projects at this scale
2. Immobilization	Solidification/Stabilization	This Process Option involves injecting and mixing an immobilization agent into the soil/residuals to bind constituents of concern within a solid mass (monolith).	Soils and sediments	Not feasible due to the anticipated large volume of material
	Vitrification	This Process Option involves removing water and melting soil to bind constituents of concern within a solid mass (monolith).	Soils	Not feasible for aquatic sediment
3. Chemical	Chemical Extraction, Chemical Destruction	In chemical treatment, chemical surfactants/solvents or oxidants are injected into the treatment area to remove or destroy constituents of concern.	Soils and sediments	Not feasible for aquatic sediment
4. Thermal	Thermal Extraction, Thermal Destruction	In thermal treatment, soils and sediments are heated to remove or destroy constituents of concern.	Soils and sediments	This process has not been successfully demonstrated full-scale for PCBs in soils, not feasible for aquatic sediments
G. Removal				
1. Source Excavation	**Excavation/Dredging**	**This Process Option involves the physical removal of solid mediacontaining constituents of concern. Potential excavation methods would include mechanical removal under “dry” or dewatered conditions and dredging of submerged materials.**	**Soils, sediments,(and associated groundwater or porewater)**	**Implementable**
2. Groundwater Removal	**Extraction Wells, Drains and Trenches**	**This Process Option includes installation of recovery wells/trenches or drains, and the collection of groundwater for further treatment, if necessary.**	**Groundwater**	**Implementable**

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See page 7 for acronyms.

Table 3-1 – Initial Screening of Technologies

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
H. Ex-Situ Treatment				
1. Bioremediation	Enhanced	Removed soils, sediments, and/or waste are landfarmed or amended to enhance the biodegradation of constituents of concern using microorganisms and nutrients in an aerobic or anaerobic environment.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale
2. Chemical	**Basic Extractive Sludge Treatment (BEST)**	**Using the BEST approach, solvent (having inverse miscibility [i.e., resistant to dissolving] in water) is used to remove PCBs from solids.**	**Soils and sediments**	**Implementable**
	Low Energy Extraction Process (LEEP)	The LEEP option calls for the use of acetone and kerosene as solvents to extract PCB from solids.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale
	Propane Extraction Process	In this extraction treatment, propane is used to extract oily organics from a water slurry of solids.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale
	Accurex Solvent Wash	In this Process Option, a proprietary Fluorocarbon-113 and methanol solvent is used to extract PCB from solids.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale
	Furfural	In this Process Option, furfural (an aromatic aldehyde) is used to extract PCBs from solids.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale

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See page 7 for acronyms.

Table 3-1 – Initial Screening of Technologies

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
2. Chemical (Cont.)	Methanol Extraction	In this Process Option, methanol is used as a solvent to extract PCBs from solids.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale
	Soil Washing	When implementing soil washing, solids are separated into fractions based on particle size and density. Water with surfactants can then be used to "wash" PCBs from solid fraction(s).	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale
	UV/Ozone/Ultrasonics	In this treatment approach, ultrasonics are used to extract PCBs from solids. PCBs destroyed by subsequent UV/ozone treatment.	Soils and sediments	Implementable
	UV/Hydrogen/Ultrasonics	In this treatment approach, ultrasonics are used to extract PCBs from solids. PCBs destroyed by subsequent UV/hydrogen treatment.	Soils and sediments	Implementable
	ELI Ecologic International, Inc. Process	This Process Option involves the gas-phase chemical reduction of organic compounds by hydrogen at temperatures of 850 °C or greater.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale
	Dechlorination (Sodium based reactions [NaPEG])	This Process Option uses sodium hydroxide/polyethylene glycol to produce rapid dehalogenation of halo-organic compounds in open air systems.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale
	Dechlorination (Potassium polyethylene glycoate based reactions [KPEG])	This Process Option uses potassium hydroxide/polyethylene glycol to produce rapid dehalogenation of halo-organic compounds in open air systems.	Soils and sediments	Implementable
	Dechlorination (APEG-PLUS)	This Process Option uses potassium hydroxide/polyethylene glycol and dimethylsulfoxide to produce rapid dehalogenation of halo-organic compounds in open air systems.	Soils and sediments	Implementable

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See page 7 for acronyms.

Table 3-1 – Initial Screening of Technologies

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
3. Thermal	Taciuk Process	This Process Option uses thermal extraction of PCBs from solids.	Soils and sediments	Implementable
	Low Temperature Thermal Desorption	This Process Option uses thermal separation of PCBs from solids at temperatures that volatilize PCBs. PCBs are then condensed and treated/disposed separately. Process requires TSCA permitting.	Soils and sediments	Implementable
	Onsite incineration	Solids are thermally treated in a fluidized bed, rotary kiln, or infrared incinerator transported to the site, which would require TSCA permitting.	Soils and sediments	Implementable
	Offsite incineration	**Solids are thermally treated in a fluidized bed, rotary kiln, or infrared incinerator located offsite, which would require TSCA permitting.**	**Soils and sediments**	**Implementable**
	Pyrolysis	This Process Option uses high temperatures to decompose PCB.	Soils and sediments	Implementable
	Radiant Energy (Photolysis)	This Process Option uses UV light energy, combined with a reducing agent, to dechlorinate PCBs.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale
	Plasma Arc	In the plasma arc approach, PCBs are thermally destroyed at very high temperatures.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale
	Wet Air Oxidation	This proprietary process uses special catalysts and relatively low temperature and high pressure to decompose organic compounds.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale

Notes:
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3. For the purposes of this screening table, “soils” are considered to also include residuals.

See page 7 for acronyms.

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Table 3-1 – Initial Screening of Technologies

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
4. Immobilization	**Solidification/ Stabilization**	**Removed soils, sediments, and/or waste materials are mixed with an immobilization agent to bind material within a solid mass (monolith).**	**Soils and sediments**	**Implementable**
	Vitrification	This Process Option is an ex-situ treatment in which solids are melted inside a chamber via electrical current, pyrolyzing PCB and incorporating remaining PCB and other constituents into glass-like monolith.	Soils and sediments	Implementable
5. Water Treatment and Discharge	**Water Treatment and Discharge**	**This Process Option includes treatment of groundwater through, filtration, flocculation, gravity settling, oil & grease separation, and/or activated carbon prior to discharging directly to surface water, discharging to a municipal sewer system, or reinjecting into the saturated unit.**	**Groundwater**	**Implementable**
I. Transportation and Disposal				
1. Offsite Disposal Via Truck or Rail	**TSCA-Regulated Landfill**	**This Process Option involves movement of soils and sediments by truck or rail for disposal in an existing TSCA permitted landfill.**	**Soils and sediments**	**Implementable**
	Solid Waste Landfill	**This Process Option involves movement of soils and sediments by truck or rail for disposal in an existing permitted solid waste landfill.**	**Soils and sediments**	**Implementable**
2. Onsite Consolidation/ Disposal	**On-Site Landfill or Containment Cell**	**This Process Option involves disposal of soils and sediments in a landfill or containment cell constructed within the Allied OU.**	**Soils and sediments**	**Implementable**

Notes:
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3. For the purposes of this screening table, “soils” are considered to also include residuals.

BEST – Basic Extractive Sludge Treatment
IC – institutional controls
LEEP – Low Energy Extraction Process
PCBs – polychlorinated biphenyls
TSCA – Toxic Substances Control Act

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Table 3-2 – Screening of Process Options

General Response Action/Remedial Technology	Representative Process Option	Effectiveness: Expected Ability to Meet RAOs	Effectiveness: Short-Term Effectiveness	Effectiveness: How Proven and Reliable Is the Technology	Implementability	Relative Cost
A. No Further Action						
	No Further Action; reliance on IRMs implemented to date	Low for RAOs 1, 2, & 3 – current exposure and potential risks outside portions of Allied OU where IRMs have not been implemented would remain; benefits of IRMs with respect to satisfying RAOs in those areas would persist. High for RAO 4 – no potential for adverse impacts from implementation.	Moderate – to the extent potential risks are present, those would persist.	IRMs implemented to date have substantially satisfied RAOs in those areas.	N/A	N/A
B. Institutional Controls						
	Access Restrictions (e.g., security fencing, warning signs)	For RAO 1 – Moderately effective in reducing direct human exposure to PCB containing media at the Allied OU by physically restricting access and informing potential trespassers of potential risks associated with the property. Low effectiveness in reducing ecological exposure. Ability to meet this RAO could be further enhanced in combination with other technologies (e.g., capping). Not effective for ecological receptors. Low for RAOs 2 & 3 – current potential for future PCB migration persists; however, could be combined with other technologies to more effectively meet these RAOs (e.g., capping, erosion controls). High for RAO 4 – minimal potential for adverse impacts from implementation.	Moderately High – no short-term exposure risks associated with implementation of remedial action. Restrictions are effective upon placement. Maintenance required to sustain effectiveness.	Reliable with appropriate inspections and maintenance	High – fencing and signage currently in place. Further restrictions readily implementable on MHLLC properties. Restrictions for other properties require landowner agreement.	Low
	Deed Restrictions	For RAO 1 – Moderately effective in reducing direct human exposure to PCB containing media at the Allied OU by informing future property owners of potential risks associated with the property and limiting property uses. Low effectiveness in reducing ecological exposure. Ability to meet this RAO could be further enhanced in combination with other technologies (e.g., capping). None for RAOs 2 & 3 – current potential for PCB migration persists; however, could be combined with other technologies to more effectively meet these RAOs (e.g., capping, erosion controls). High for RAO 4 – minimal potential for adverse environmental impacts from implementation.	High – no short-term exposure risks associated with implementation of remedial action.	Reliable with property use in accordance with deed restrictions.	High – some deed restrictions are already in place. Further restrictions readily implementable on MHLLC properties. Negotiations with potentially affected landowner(s) would be necessary.	Low

Notes:
Shading denotes process options not retained for further consideration.
See acronyms on page 7.

Table 3-2 – Screening of Process Options

General Response Action/Remedial Technology	Representative Process Option	Effectiveness			Implementability	Relative Cost
		Expected Ability to Meet RAOs	Short-Term Effectiveness	How Proven and Reliable Is the Technology		
	Fish Consumption Advisories	High for mitigating human exposure, and low for mitigating ecological exposure under RAO 1. Mitigates the potential for human exposure by reducing potential for consumption of fish in Portage Creek containing PCBs. Ability to meet this RAO for humans could be further enhanced in combination with other technologies. None for RAOs 2 & 3 – current potential for future PCB migration persists; however, could be combined with other technologies to more effectively meet these RAOs. High for RAO 4 – minimal potential for adverse environmental impacts from implementation.	High – no short-term exposure risks associated with implementation of remedial action.	Reliability is dependent on effective communication of advisories.	High – advisories currently in place can be maintained and updated until appropriate to remove.	Low
C. Monitoring						
	Periodic Visual Observations and/or Field Sampling to Monitor Site Conditions	None for RAOs 1, 2 & 3 – current potential for human exposure and future PCB migration persists; however, could be combined with other technologies to confirm stability of site exposure controls, source controls, and/or containment to more effectively meet these RAOs. High for RAO 4 – minimal potential for adverse impacts from implementation.	High – limited short-term exposure risks associated with onsite visits and field sampling activities.	Monitoring techniques well established. Reliability subject to adequacy of supporting monitoring plans.	High – readily implementable. Experienced field personnel, sampling equipment, and supplies are readily available.	Moderately Low (depending on time period and intensity of monitoring activities)
D. In-Situ Containment						
1. Engineered Barrier	Engineered Landfill Cap – Earthen Cover	High for RAOs 1 & 2 –reduces potential for human and ecological exposure to PCB via direct contact as well as PCB migration via erosion or surface water runoff. Low for RAO 3 – minimally reduces surface water infiltration; subsurface groundwater migration potential persists. Ability to meet this RAO could be further enhanced in combination with other technologies. Moderate for RAO 4 – some potential for adverse impacts due to potential disturbance of PCB-containing residuals as part of the earthen cover installation process; however, can be mitigated with proper PPE and air emissions controls and monitoring.	Moderate – short-term disturbances of the OU may temporarily increase exposures via air emissions, stormwater erosion, and increased infiltration of precipitation as a result of surface re-grading and consolidation activities.	High – technologies are well established, widely applied, and are proven to be reliable over long time scales at sites of similar size and characteristics.	High – experienced contractors and materials are readily available.	Moderate

Notes:
Shading denotes process options not retained for further consideration.
See acronyms on page 7.

Table 3-2 – Screening of Process Options

General Response Action/Remedial Technology	Representative Process Option	Effectiveness			Implementability	Relative Cost
		Expected Ability to Meet RAOs	Short-Term Effectiveness	How Proven and Reliable Is the Technology		
1. Engineered Barrier (continued)	Engineered Landfill Cap – Impermeable Cover System	High for RAOs 1 & 2 – eliminates potential for human and ecological exposure to PCB via direct contact and reduces the potential for PCB migration via erosion or surface water runoff. Moderate for RAO 3 – reduces surface water infiltration via the landfill cap; however, subsurface groundwater migration potential persists. Ability to meet this RAO could be further enhanced in combination with other technologies. Moderate for RAO 4 – some potential for adverse impacts due to potential disturbance of PCB-containing residuals as part of capping process; however, can be mitigated with proper PPE and air emissions controls and monitoring.	Moderate – short-term disturbances of the OU may temporarily increase exposures as a result of surface re-grading and consolidation activities.	High – landfill capping technologies are well established, widely applied, and are proven to be reliable over long time scales at sites of similar size and characteristics.	High – experienced contractors and suitable capping materials are readily available. Landfill cover system design requirements are established in Part 115 and 201. Appropriate engineering controls are readily available to mitigate short-term risks.	Moderate to High
	Hazardous Waste Landfill Containment System	High for RAOs 1 & 2 – hazardous waste landfill containment system eliminates potential for human and ecological exposure to PCB via direct contact and reduces the potential for PCB migration via erosion or surface water runoff. High for RAO 3 – reduces surface water infiltration via the landfill cap; the bottom liner of the hazardous waste landfill containment cell would also reduce the potential for PCBs to migrate to the groundwater. Ability to meet this RAO could be further enhanced in combination with other technologies. Very Low for RAO 4 – disturbance of nearly all of the PCB-containing material as part of remedial action results in significant increased risk to human health and the environment given the volume of material subject to removal. In addition, there would be significant exposure risks and runoff issues with the temporary stockpiles of materials – a temporary cover would need to be installed during liner installation to prevent/minimize infiltration from precipitation.	A hazardous waste landfill containment system approach would involve removing all targeted materials, temporarily stockpiling these materials within the foot print of the hazardous waste landfill containment cell, constructing and lining a hazardous waste landfill containment cell, re-emplacing all stock-piled materials within the lined cell, excavation and placement of materials in the cell and constructing an impermeable cover. During hazardous waste landfill containment cell construction and excavation, stormwater and groundwater treatment and disposal would be required along with potential air quality controls. The potential for direct exposure via air emissions, stormwater erosion and increased infiltration of precipitation and potential for migration during construction is significantly heightened under this option.	High – this is a proven and reliable technology.	Low – space limitations for stockpiling removed materials, limited capacity for final placement of all PCB containing materials, and stormwater management restrictions present significant obstacles to implementation of the hazardous waste landfill containment system process option. In addition, if required to comply with landfill design-related ARARs, the bottom of the containment cell would need to be located several feet above the water table – this would require fairly deep excavations extending below the water table, so the walls of the excavations would have to be supported, and either the excavation areas would have to be dewatered to remove in the dry, or removed materials would have to be dried/stabilized before re-emplacement of materials within the lined hazardous waste landfill containment cell.	Very High

Notes:
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Table 3-2 – Screening of Process Options

General Response Action/Remedial Technology	Representative Process Option	Effectiveness			Implementability	Relative Cost
		Expected Ability to Meet RAOs	Short-Term Effectiveness	How Proven and Reliable Is the Technology		
2. Erosion Control	Rip Rap	In combination with capping, further enhances ability to meet RAOs 1 & 2 by reducing erosion potential of Portage Creek bank soils and thereby further maintaining stability of capping and backfill materials necessary to achieve exposure reductions and source controls. Low for RAO 3, as the remedial action does not influence groundwater conditions. High for RAO 4, little to no short-term exposure risks associated with this option.	High – immediate stability achieved. Possible short-term impairment to shoreline ecosystems can be mitigated by use of engineering controls and restoration measures. Limited short-term exposure risks associated with implementation of remedial action.	High – proven and reliable long-term with proper inspection and maintenance.	High – experienced contractors and materials are readily available. Michigan Best Management Practices are available for reference.	Moderate
2. Erosion Control (continued)	Sheetpile	In combination with capping, further enhances ability to meet RAOs 1 & 2 by reducing erosion potential of Portage Creek bank soils and thereby further maintaining stability of capping and backfill materials necessary to achieve exposure reductions and source controls. Moderate for RAO 3, depending on sheetpile type and location, could serve as a physical barrier to groundwater flow towards Portage Creek. High for RAO 4, limited short-term exposure risks associated with this option.	High – immediate stability achieved. Possible short-term impairment to shoreline ecosystems can be mitigated by use of engineering controls and designs that incorporate eco-functions. Limited short-term exposure risks associated with implementation of remedial action.	High – proven and reliable long-term with proper inspection and maintenance.	High – experienced contractors and materials are readily available.	Moderate to High
3. Hydraulic Containment	Groundwater Extraction (e.g., horizontal or vertical extraction wells, French drains, trenches, sumps to remove groundwater from locations upgradient, downgradient, or side-gradient to contaminated groundwater zone.)	Low for RAOs 1 & 2 – does little to reduce potential for human and ecological exposure to PCB or PCB migration via erosion or surface water runoff. High for RAO 3 – technology is geared towards mitigating potential for PCBs in groundwater to migrate offsite. High for RAO 4, limited short-term exposure risks associated with this option.	High – limited short-term exposure risks associated with implementation of remedial action.	High – groundwater containment and extraction is a commonly implemented remedial technology.	High – experienced contractors and materials are readily available.	Moderate to High depending on treatment requirements, volume and duration.

Notes:
Shading denotes process options not retained for further consideration.
See acronyms on page 7.

Table 3-2 – Screening of Process Options

General Response Action/Remedial Technology	Representative Process Option	Effectiveness			Implementability	Relative Cost
		Expected Ability to Meet RAOs	Short-Term Effectiveness	How Proven and Reliable Is the Technology		
E. Removal						
1. Source Excavation	Excavation	High for RAOs 1, 2, & 3 – In combination with offsite transportation and disposal, removal of PCB-containing materials would effectively reduce potential for human exposure and PCB migration in the long-term. Very Low for RAO 4 – disturbance of PCB-containing material as part of remedial action results in significant increased risk to human health and the environment given volume of material subject to removal. If large-volume excavation of all PCB-containing materials is combined with offsite transportation and disposal, tens of thousands of trucks would be required over a period of up to several years resulting in significantly increased potential for offsite releases over a broader area.	Very Low – significant potential for adverse effects to human health and the environment via disturbance and potential remobilization of PCB-containing materials in air, surface water and potentially groundwater.	High – excavation is a commonly implemented remedial technology.	Moderate – experienced contractors and materials are readily available. Handling, transportation, and disposal of larger volumes of material are a significant implementation challenge.	Very High
2. Groundwater Removal	Extraction Wells and Trenches	Low for RAOs 1 & 2 – does little to reduce potential for human and ecological exposure to PCB via direct contact or PCB migration via erosion or surface water runoff. High for RAO 3 – technology is geared towards mitigating potential for PCBs in groundwater to migrate offsite. High for RAO 4, limited short-term exposure risks associated with this option.	High – limited short-term exposure risks associated with implementation of remedial action.	High – groundwater extraction is commonly implemented remedial technology.	High – experienced contractors and materials are readily available.	Moderate to High depending on treatment requirements, volume and duration.
F. Ex-Situ Treatment						
1. Chemical	Basic Extractive Sludge Treatment	Would be used in conjunction with removal actions and/or onsite consolidation to satisfy RAOs 1, 2, & 3. Either on its own or in combination with removal, provides limited ability to meet RAO 4 as a result of disturbance and relocation of significant volume of PCB-containing materials.	Low – significant potential for adverse effects to human health and the environment via disturbance and relocation of PCB-containing materials.	Moderate – shown to be effective at destroying PCBs in soils and sediments. Would require treatability study to determine whether site-specific factors make it feasible. Has not been proven effective at treating PCBs in paper-making residuals.	Low – scale of the OU and quantity of PCB-containing materials subject to treatment presents a significant limitation to application of treatment technologies. Issues associated with offsite transportation component are present as with removal response action.	High to Very High Not retained based on short-term effectiveness, proven applicability, and implementability.

Notes:
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See acronyms on page 7.

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Table 3-2 – Screening of Process Options

General Response Action/Remedial Technology	Representative Process Option	Effectiveness			Implementability	Relative Cost
		Expected Ability to Meet RAOs	Short-Term Effectiveness	How Proven and Reliable Is the Technology		
2. Thermal	Offsite incineration	Would be used in conjunction with removal actions and/or onsite consolidation to satisfy RAOs 1, 2, & 3. Either on its own or in combination with removal, provides limited ability to meet RAO 4 as a result of disturbance and relocation of significant volume of PCB-containing materials.	Very Low – significant potential for adverse effects to human health and the environment via disturbance and offsite relocation of PCB-containing materials. Likely to be significant localized air quality impacts associated with incineration. Emissions data collected during full-scale operations have indicated that dioxin emissions may be elevated.	Process proven to be effective at destroying PCBs in soils and sediments.	Low – scale of the OU and quantity of PCB-containing materials subject to treatment presents a significant limitation to application of treatment technologies. Issues associated with offsite transportation component are present as with removal response action.	High to Very High Not retained based on short-term effectiveness, implementability, and cost.
3. Immobilization	Solidification/ Stabilization	Would be used in conjunction with removal actions and/or onsite consolidation to satisfy RAOs 1, 2, & 3. Either on its own or in combination with removal, provides limited ability to meet RAO 4 as a result of disturbance and relocation of significant volume of PCB-containing materials.	Very Low – significant potential for adverse effects to human health and the environment via disturbance and offsite relocation of PCB-containing materials. Potential for release of stabilization agents.	Has been used ex-situ full scale at other Superfund sites. Utilized to reduce free moisture and stabilize materials for disposal purposes.	Moderate – technologies, equipment and materials are available; however, scale of the OU and quantity of PCB-containing materials subject to treatment presents a significant limitation to application of treatment technologies.	Moderate
4. Water Treatment and Discharge	Various treatment options (filtration, activated carbon) and potential discharge locations (adjacent surface waters, POTW)	Low for RAOs 1 & 2 – does little to reduce potential for human and ecological exposure to PCB via direct contact or PCB migration via erosion or surface water runoff. High for RAO 3 – in combination with groundwater removal, technology addresses mitigating potential for PCBs in groundwater to migrate to Portage Creek or offsite. High for RAO 4, limited short-term exposure risks associated with this option.	High – limited short-term exposure risks associated with implementation of water treatment in combination with groundwater removal.	High – water treatment is a proven remedial technology.	High – experienced contractors and materials are readily available.	Moderate to High
G. Transportation and Disposal						
1. Offsite Disposal	Overland transport to TSCA-Regulated and/or Solid Waste Landfill	High for RAOs 1, 2, & 3 – in combination with removal, offsite transportation and disposal of PCB-containing materials would effectively reduce potential for human exposure and PCB migration in the long-term. Very Low for RAO 4 – disturbance of PCB-containing material as part of remedial action results in potentially significant increase to human health and the environment given large volume of material subject to removal. Large-scale offsite transportation component may require tens of thousands of trucks or containers to traverse public roads resulting in significantly increased potential for offsite releases over a broader area.	Very Low – significant potential for adverse effects to human health and the environment via disturbance and offsite relocation of PCB-containing materials.	High – offsite transportation and disposal is commonly implemented practice.	Moderately High – experienced contractors and materials are readily available. Timing of implementation is dependent upon proper project planning and availability of offsite disposal locations. External factors (e.g., community concerns, traffic routes, trucking resources, offsite landfill capacity) may limit rate of disposal and increase overall duration of remedy implementation.	High to Very High Depending on TSCA material volumes relative to total volume.

Notes:
Shading denotes process options not retained for further consideration.
See acronyms on page 7.

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Table 3-2 – Screening of Process Options

General Response Action/Remedial Technology	Representative Process Option	Effectiveness			Effectiveness	Effectiveness
		Expected Ability to Meet RAOs	Short-Term Effectiveness	How Proven and Reliable Is the Technology		
2. Onsite Consolidation/ Disposal	Construct onsite containment cell and emplace excavated materials	In association with excavation, relocation to disposal cell would contribute to attainment of RAOs 1, 2, and 3; however, would entail significant short-term impacts associated with disturbance and relocation of PCB-containing materials under RAO 4.	Low – significant impacts associated with disturbance of OU, equivalent to or greater than those associated with excavation and offsite disposal due to larger footprint of operations involved in temporary storage of materials, etc. due to space constraints.	Once cell completed, dependent on design and construction of cell components and cap.	Low – limited implementability subject to space limitations for onsite relocation, temporary storage, cell construction and filling operations. There may be disposal capacity constraints, depending on the volume of material to be relocated.	High to Very High

Notes:
Shading denotes process options not retained for further consideration.

IRMs – interim remedial measures
MHLLC – Millennium Holdings, LLC
N/A – not applicable
OU – operable unit
PCBs – polychlorinated biphenyls
PPE – personal protective equipment
POTW – publicly-owned treatment works
RAOs – remedial action objectives
TSCA - Toxic Substances Control Act

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Table 3-3 – Retained Response Actions by Sub-Area

Sub-Area	Soil and Sediment Response Actions									Contingent Groundwater Remedy[4]
	No Further Action	Institutional Controls	Monitoring	In-Situ Containment		Removal/ Excavation	Ex-Situ Treatment	Offsite Disposal	Onsite Consolidation	
				Earthen Cover	Impermeable Cover System					
Former Operational Areas										
Monarch HRDL	X	X	X	X	X	X	X	X		X
Former Monarch Raceway	X	X		X		X	X	X	X	
Former Type III Landfill	X	X	X	X	X	X	X		X	X
Western Disposal Area	X	X	X	X	X	X	X	X		X
Portion on Panelyte Property[1]	X	X		X	X	X	X	X	X	
Panelyte Marsh[2]	X	X		X		X	X	X	X	
Conrail Property[3]	X	X		X	X	X	X	X	X	
Bryant HRDL/FRDLs	X	X	X		X	X	X	X		X
Residential and Commercial Properties										
Residential Properties	X	X		X		X	X	X	X	
MHLLC-owned property (adjacent to residential properties)	X	X		X		X	X	X	X	
Commercial Properties (Goodwill, Consumers Power, MHLLC's Alcott St Parking Lot)	X	X		X		X	X	X	X	

[1] Sloped area on Panelyte Property immediately north of Western Disposal Area, adjacent to Panelyte Marsh.
[2] Fringe of Panelyte Marsh at bottom of sloped area adjacent to Western Disposal Area.
[3] Portion of Conrail property immediately adjacent to Western Disposal Area.
[4] Included for potential contingent remedy – options are inclusive of various response actions to be evaluated, if appropriate, contingent upon monitoring and performance of other remedy components.

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Table 5-1 - Cost Estimate for Remedial Alternative 2A

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1.	Pre-Construction Field Survey	1	LS	$60,000	$60,000
2.	Air Monitoring Program	200	DAY	$1,200	$240,000
3.	Temporary Fencing	1	LS	$10,000	$10,000
4.	Decontamination Area	1	EA	$35,000	$35,000
5.	Temporary Construction Access Roads	1	LS	$100,000	$100,000
6.	Clearing & Grubbing	20	AC	$9,000	$180,000
7.	Temporary Steel Sheeting	1	LS	$410,000	$410,000
8.	Upgrade of Existing Water Treatment System and Monthly Maintenance Associated with Construction	1	LS	$95,000	$95,000
9.	Utility Protection / Relocation	1	LS	$100,000	$100,000
10.	Temporary Stormwater Management and Erosion and Sediment	1	LS	$420,000	$420,000
11.	Well Abandonment	18	EA	$500	$9,000
				Site Preparation Subtotal:	**$1,659,000**
Excavation and Consolidation					
12.	Survey	8	WK	$8,600	$68,800
13.	Soil Removal and Consolidation	225,000	CY	$10	$2,250,000
14.	Confirmation Sampling	140	EA	$360	$50,400
				Excavation and Consolidation Subtotal:	**$2,369,200**
Final Cover System					
15	Grade Verification Surveys	8	WK	$8,600	$68,800
16.	Soil Grading Layer (Select Fill)	25,300	CY	$20	$506,000
17.	Geotextile Separation Layer (8-oz/sy)	181,800	SY	$2.25	$409,050
18.	Soil Protection / Drainage Layer (Sand)	50,500	CY	$20	$1,010,000
19.	Topsoil Layer	25,300	CY	$30	$759,000
20.	Seed & Mulch	31	AC	$3,500	$108,500
				Final Cover System Subtotal:	**$2,861,350**
Permanent Storm Water Management					
21.	Vegetated Swales	9,200	LF	$15	$138,000
22.	Riprap-Lined Swales	3,750	LF	$100	$375,000
23.	Riprap Slope Protection	1	LS	$370,000	$370,000
24.	Culverts	900	LF	$20	$18,000
25.	Subsurface Drain Piping	3,900	LF	$45	$175,500
26.	Stormwater Basins	3	EA	$60,000	$180,000
				Permanent Storm Water Management Subtotal:	**$1,256,500**
Restoration					
27.	As-Built Survey	6	WK	$8,600	$51,600
28.	Backfill	50,000	CY	$20	$1,000,000
29.	Topsoil	6,500	CY	$30	$195,000
30.	Seed & Mulch	8	AC	$3,500	$28,000
31.	Permanent Gravel Access Roads	1	LS	$275,000	$275,000
				Restoration Subtotal:	**$1,549,600**
Post-Closure Monitoring Features Installation					
32.	Installation of Permanent Gas Monitoring Probes	6	EA	$5,000	$30,000
33.	Installation of Perimeter Gas Venting Trenches	19,250	SF	$35	$673,750
34.	Installation of Post-Closure Groundwater Monitoring Well Network	20	EA	$5,000	$100,000
				Post-Closure Monitoring Features Installation Subtotal:	**$803,750**
				CAPITAL COST SUBTOTAL:	**$10,499,400**
				Mobilization/Demobilization (5% of Subtotal Capital Cost):	**$524,970**
				Administration, Engineering, and Construction Oversight (10% of Subtotal Capital Cost):	**$1,049,940**
				Independent Construction Quality Assurance (5% of Final Cover System Capital Costs):	**$143,068**
				Contingency (20% of Subtotal Capital Cost):	**$2,099,880**
				TOTAL CAPITAL COST:	**$14,317,258**

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Table 5-1 - Cost Estimate for Remedial Alternative 2A

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
II. OPERATION AND MAINTENANCE (O&M) COSTS					
Post-Closure Inspections & Maintenance					
35.	Years 1-5	5	YR	$100,000	$500,000
36.	Years 6-30	1	LS	$290,000	$290,000
				Post-Closure Inspections & Maintenance Subtotal:	**$790,000**
Post-Closure Landfill Gas Monitoring & Reporting					
37.	Years 1-5	5	YR	$4,000	$20,000
38.	Years 6-30	1	LS	$24,000	$24,000
				Post-Closure Landfill Gas Monitoring & Reporting Subtotal:	**$44,000**
Post-Closure Groundwater Sampling & Reporting					
39.	Years 1-5	5	YR	$250,000	$1,250,000
40.	Years 6-30	1	LS	$1,500,000	$1,500,000
				Post-Closure Groundwater Sampling & Reporting:	**$2,750,000**
				O&M COST SUBTOTAL:	**$3,584,000**
				Contingency (20% of Subtotal O&M Cost):	**$716,800**
				TOTAL O&M COST:	**$4,300,800**
				TOTAL ESTIMATED COST:	**$18,618,058**
				ROUNDED TO:	**$18,600,000**

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Table 5-1 - Cost Estimate for Remedial Alternative 2A

General Notes:

A. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

B. Unit prices are based on 2009 dollars.

C. All volumes represent in-place measures.

D. Where not otherwise noted, unit cost is based on past project experience.

E. The total conceptual consolidation/cover system area is approximately 31 acres, subdivided as follows:

- 10 acres: Former Type III Landfill
- 12 acres: Western Disposal Area
- 6 acres: Monarch HRDL
- 1.8 acres: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
- 1.5 acres: Residential/MHLLC-Owned Properties (including Golden Age)

F. The total area of PCB-containing soil (i.e., consolidation/cover system area as well as peripheral and outlying soil removal areas) is approximately 39 acres, subdivided as follows:

- 13.6 acres: Former Type III Landfill
- 15.6 acres: Western Disposal Area (including Panelyte Property, Panelyte Marsh, and Conrail Property)
- 6.8 acres: Monarch HRDL
- 1.8 acres: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
- 1.5 acres: Residential/MHLLC-Owned Properties (including Golden Age)

G. Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

H. "RS Means" refers to RS Means Heavy Construction Cost Data 2009.

I. "Aerial Photos" refers to images obtained from Microsoft® Live Search website (http://maps.live.com).

J. CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton WK=Week; MO=Month.

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Table 5-1 - Cost Estimate for Remedial Alternative 2A

Item Notes:

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking OU features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during PCB-containing material handling only (e.g., excavation, consolidation, subgrade preparation), the duration of which is assumed to be approximately 10 months total. It is also assumed that 3 PCB PolyUrethane Foam (PUF) samples will be collected per day (i.e., one-sample up-wind and two down-wind samples). Air monitoring unit cost includes the preliminary estimated cost of the rental equipment ($260/day), analysis ($600 for 3 samples), shipping ($40/day), and labor ($300/day).

3. Temporary fence quantity represents the additional fencing needed to completely enclose and secure the various work areas. It is assumed that existing fence will be utilized, to the extent practicable.

4. Decontamination area is assumed to be an approximately 50-foot by 50-foot area, which consists of 18 inches of gravel underlain with a 40-mil high density polyethylene liner cushioned on both sides by a 12-ounce non-woven geotextile. Decontamination area is assumed to be sloped to a sump for collection of decontamination fluids.

5. Temporary access road unit cost is based on an assumed 1,900 foot-long, 24 foot-wide, 6-inch-thick gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600X). Gravel unit cost ($36/cubic yard) is based on a $17 per ton gravel cost (delivered), a 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard), and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600X) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

6. Clearing and grubbing unit cost is based on cutting and chipping of medium trees 12 to 18 inches in diameter and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system. Total clearing and grubbing area was estimated from aerial photos.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL. The estimated cost to drive, extract, and salvage the steel sheeting is estimated to be approximately $20 per square foot, based on RS Means. An additional $20,000 is included to account for the estimated total cost of installing an access road to facilitate sheeting installation with a crane.

8. Cost includes an assumed cost of $15,000 to upgrade the capacity of the existing water treatment system and a monthly maintenance cost of $5,000 to account for additional maintenance needs associated with construction activities.

9. Utility protection/relocation cost includes the estimated cost to relocate up to 7 electrical poles ($10,000/pole) around the removal and consolidation areas. In addition, the cost includes approximately $30,000 for the estimated expenses associated with relocation/replacement of miscellaneous onsite utilities (e.g., electrical line to the onsite water treatment facility, existing piping).

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Table 5-1 - Cost Estimate for Remedial Alternative 2A

10. Temporary stormwater management and erosion and sedimentation controls include temporary sediment controls (e.g., silt fence, haybales, filter socks, and stone check dams), miscellaneous water management (e.g., pumping of collected water to water treatment system, temporary piping/culverts), temporary seeding, and dust controls. In addition, unit cost includes maintenance costs for an approximately 2-year duration.

11. Well abandonment includes the abandonment of existing monitoring wells, piezometers, and seep wells located within the footprint of the conceptual consolidation and stormwater basin areas.

12. Survey cost includes stake-out activities associated with excavation, consolidation, construction, and confirmation sampling activities.

13. Soil removal and consolidation quantity represents the total quantity of in-situ material requiring excavation prior to consolidation within the Former Type III Landfill, Western Disposal Area, and Monarch HRDL consolidation areas. Soil removal and consolidation cost includes excavation and loading of PCB-containing materials, onsite transport to placement area within the consolidation areas, and placement and compaction in 12-inch lifts within the consolidation areas. Estimated quantities are based on removal and consolidation of approximately 190,000 cubic yards of material along the peripheral areas of the Former Type III Landfill and the Western Disposal Area (including the Panelyte Property, Panelyte Marsh, and Conrail Property), and approximately 35,000 cubic yards of material along the peripheral area of the Monarch HRDL.

14. Confirmation sample quantity assumes that removal areas, located outside of the conceptual consolidation area (approximately 8 acres or 350,000 square feet), will be sampled on a 50 foot by 50 foot grid to confirm removal of PCB-containing material. Sampling costs are assumed to be the same as the costs for analyses (i.e., $180/sample for analysis; therefore, $180 x 2 = $360 for sampling and analysis).

15. Grade verification survey cost estimate includes two surveys of the consolidation/cover system areas. The first survey would be performed prior to commencing filling activities. The second survey would be performed immediately prior to the installation of the liner system (i.e., liner subgrade survey). Each survey is assumed to take approximately four weeks.

16. Soil grading layer cost estimate is based on an assumed 6-inch-thick layer of select fill covering the entire consolidation/cover system areas and is the first layer of the earthen cover system. Select fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL
    - 1,500 cubic yards: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
    - 1,200 cubic yards: Residential/MHLLC Properties (including Golden Age)

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17. Geotextile separation layer cost estimate assumes utilizing a non-woven geotextile covering the entire cover system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on information provided by geotextile manufacturer. Estimated quantities are subdivided as follows:

    - 58,100 square yards: Former Type III Landfill
    - 69,700 square yards: Western Disposal Area
    - 34,800 square yards: Monarch HRDL
    - 10,500 square yards: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
    - 8,700 square yards: Residential/MHLLC Properties (including Golden Age)

18. Soil protection/drainage layer consists of a 1-foot-thick layer of sand covering the entire cover system area. Sand fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 16,150 cubic yards: Former Type III Landfill
    - 19,360 cubic yards: Western Disposal Area
    - 9,680 cubic yards: Monarch HRDL
    - 2,900 cubic yards: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
    - 2,400 cubic yards: Residential/MHLLC Properties (including Golden Age)

19. Topsoil layer consists of a 6-inch-thick layer of topsoil covering the entire cover system areas. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement. Estimated quantities are subdivided as follows:

    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL
    - 1,500 cubic yards: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
    - 1,200 cubic yards: Residential/MHLLC Properties (including Golden Age)

20. Seed and mulch cost estimate is based on seeding and mulching the entire area subject to consolidation/final cover system. The per acre unit cost is derived based on an estimated cost of $3,500/acre, which was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

21. Total length of the vegetated swale is based on a conceptual cover system layout prepared for cost estimating purposes only, and includes both perimeter swales/ditches and mid-slope swales. In addition, it is assumed that the linear foot unit cost to construct a perimeter swale is equal to the cost to construct a mid-slope swale. Vegetated swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and 2-foot-deep channel geometry. Vegetated swale unit cost includes the cost to excavate the swale ($2/cubic yard), install a 6-inch topsoil layer ($30/cubic yard), and cover with erosion control matting ($0.75/square yard). Seeding of vegetated swale is included in Item #20.

22. Total length of the riprap-lined swale is based on a conceptual cover system layout prepared for cost estimating purposes only. Riprap-lined swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and a 2-foot-deep channel geometry. Channel lining is assumed to consist of a 15-inch-thick layer of riprap underlain with a non-woven geotextile. Riprap-lined swale unit cost includes the cost to excavate the swale ($2/cubic yard), install the non-woven geotextile ($2.25/square yard), and install riprap ($100/cubic yard).

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23. Riprap slope protection quantity is based on an assumed 40-foot-wide, 1,200-foot-long, by 15-inch-thick layer of riprap installed along the southeast bank of Portage Creek to protect the toe of the cover system side slope. Riprap material and placement cost is approximately $100 per cubic yard. Non-woven geotextile (i.e., Mirafi S800) unit cost ($2.25/square yard) is based on information provided by the manufacturer.

24. Total length of culvert piping is based on a conceptual cover system layout prepared for cost estimating purposes only. Unit cost ($20/linear foot) is based on an assumed 18-inch diameter high density polyethylene (HDPE) pipe, Type S, and includes material and installation costs. Unit cost was obtained from RS Means.

25. It is anticipated that subsurface drainage would be installed at the interface between the consolidation area and the existing Bryant HRDLs and FRDLs liner system. Liner system grades at the interface are assumed to slope downward on a 4 on 1 slope forming a v-notch channel containing the subsurface drainage piping. Subsurface drainage is assumed to consist of a 6-inch diameter perforated pipe ($8.45 /linear foot) and a 6-inch-thick layer of drainage stone mounded over top the pipe ($61.50/cubic yard). In addition, the perforated pipe and drainage stone are wrapped in a non-woven geotextile ($2.25/square yard). Pipe and drainage stone unit costs were obtained from RS Means, and include material and installation costs. Additional geotextile material is assumed for a full-width overlap of each side of the geotextile in the longitudinal direction.

26. Stormwater basin unit cost represents an average per basin cost, which was developed from a conceptual stormwater basin configuration. Stormwater basin unit cost includes construction of an embankment (where applicable), topsoiling and seeding of the entire basin area, and construction of a corrugated metal pipe riser outlet structure. It is preliminarily assumed that a stormwater basin will be required for each of the Former Type III landfill, Western Disposal Area, and Monarch HRDL consolidation/cover system areas.

27. As-built survey consists of a detailed topographic and feature survey of the disturbed area. As-built survey cost includes both field and office support costs.

28. Estimated cost for backfill is not based on calculation, rather it is an estimate of the volume of clean fill material that will be required to backfill the peripheral soil removal areas associated with the Former Type III Landfill, Western Disposal Area, and Monarch HRDL to appropriate subgrade elevation. Actual volume to be determined during design phase.

29. Topsoil quantity is based on covering approximately 8 acres of soil removal area, located outside the limits of capping, with 6 inches of topsoil. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement.

30. Seed and mulch quantity is based on covering the 8 acres of topsoil placed over the outlying soil removal areas, as necessary to promote vegetative growth. Unit cost (i.e., $3,500/acre) was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

31. Permanent access road quantity based on an assumed 7,600 linear feet of newly constructed road that will be required to access various portions of the cover system area for maintenance purposes. Permanent access roads are assumed to consist of a 24 foot-wide, 1-foot-thick, gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600x). Access road unit cost was based on a gravel material cost of $17 per ton (delivered), an assumed 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard) and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600x) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

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32. The estimated cost for installation of permanent gas probes is based on the assumption that a series of six permanent gas monitoring probes will be installed along perimeters of the Western Disposal Area and the Monarch HRDL to monitor landfill gas concentrations at locations adjacent to neighboring properties.

33. The estimated cost for installation of perimeter gas venting trenches is based on the assumption that 5-foot deep, 2-foot wide gas venting trenches, consisting of trenches filled with crushed stone/pea gravel and perforated piping affixed with wind turbine ventilators, will be installed along the perimeters of the Western Disposal Area and the Monarch HRDL to vent landfill gas from the subsurface before encroaching onto adjacent neighboring properties.

34. The estimated cost for installation of a post-closure groundwater monitoring network is based on the assumption that a series of groundwater monitoring wells will be installed along the entire perimeters of the Former Type III Landfill, the Western Disposal Area, and the Monarch HRDL for purposes of collecting post-closure groundwater samples.

35. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a quarterly basis for the first 5 years of the post-closure period.

36. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the net present value (NPV) or present worth, and is based on an annual cost of approximately $25,000 at a 7% discount rate.

37. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a quarterly basis for the first 5 years of the post-closure period.

38. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $2,000 at a 7% discount rate.

39. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a quarterly basis for the first 5 years of the post-closure period, and will include PCB and a variety of non-PCB constituents.

40. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period, and will include PCB and a variety of non-PCB constituents. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $125,000 at a 7% discount rate.

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Table 5-2 - Cost Estimate for Remedial Alternative 2B

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1.	Pre-Construction Field Survey	1	LS	$60,000	$60,000
2.	Air Monitoring Program	200	DAY	$1,200	$240,000
3.	Temporary Fencing	1	LS	$10,000	$10,000
4.	Decontamination Area	1	EA	$35,000	$35,000
5.	Temporary Construction Access Roads	1	LS	$100,000	$100,000
6.	Clearing & Grubbing	20	AC	$9,000	$180,000
7.	Temporary Steel Sheeting	1	LS	$410,000	$410,000
8.	Upgrade of Existing Water Treatment System and Monthly Maintenance Associated with Construction	1	LS	$95,000	$95,000
9.	Utility Protection / Relocation	1	LS	$100,000	$100,000
10.	Temporary Stormwater Management and Erosion and Sediment	1	LS	$420,000	$420,000
11.	Well Abandonment	18	EA	$500	$9,000
				Site Preparation Subtotal:	**$1,659,000**
Excavation and Consolidation					
12.	Survey	8	WK	$8,600	$68,800
13.	Soil Removal and Consolidation	265,500	CY	$10	$2,655,000
14.	Confirmation Sampling	192	EA	$360	$69,120
				Excavation and Consolidation Subtotal:	**$2,792,920**
Final Cover System					
15.	Grade Verification Surveys	8	WK	$8,600	$68,800
16.	Soil Grading Layer (Select Fill)	22,600	CY	$20	$452,000
17.	Geotextile Separation Layer (8-oz/sy)	162,600	SY	$2.25	$365,850
18.	Soil Protection / Drainage Layer (Sand)	45,200	CY	$20	$904,000
19.	Topsoil Layer	22,600	CY	$30	$678,000
20.	Seed & Mulch	28	AC	$3,500	$98,000
				Final Cover System Subtotal:	**$2,566,650**
Permanent Storm Water Management					
21.	Vegetated Swales	9,200	LF	$15	$138,000
22.	Riprap-Lined Swales	3,750	LF	$100	$375,000
23.	Riprap Slope Protection	1	LS	$370,000	$370,000
24.	Culverts	900	LF	$20	$18,000
25.	Subsurface Drain Piping	3,900	LF	$45	$175,500
26.	Stormwater Basins	3	EA	$60,000	$180,000
				Permanent Storm Water Management Subtotal:	**$1,256,500**
Restoration					
27.	As-Built Survey	6	WK	$8,600	$51,600
28.	Backfill	88,900	CY	$20	$1,778,000
29.	Topsoil	8,900	CY	$30	$267,000
30.	Seed & Mulch	11	AC	$3,500	$38,500
31.	Permanent Gravel Access Roads	1	LS	$275,000	$275,000
				Restoration Subtotal:	**$2,410,100**
Post-Closure Monitoring Features Installation					
32.	Installation of Permanent Gas Monitoring Probes	6	EA	$5,000	$30,000
33.	Installation of Perimeter Gas Venting Trenches	19,250	SF	$35	$673,750
34.	Installation of Post-Closure Groundwater Monitoring Well Network	20	EA	$5,000	$100,000
				Post-Closure Monitoring Features Installation Subtotal:	**$803,750**
				CAPITAL COST SUBTOTAL:	**$11,488,920**
				Mobilization/Demobilization (5% of Subtotal Capital Cost):	**$574,446**
				Administration, Engineering, and Construction Oversight (10% of Subtotal Capital Cost):	**$1,148,892**
				Independent Construction Quality Assurance (5% of Final Cover System Capital Costs):	**$128,333**
				Contingency (20% of Subtotal Capital Cost):	**$2,297,784**
				TOTAL CAPITAL COST:	**$15,638,375**

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Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
II. OPERATION AND MAINTENANCE (O&M) COSTS					
Post-Closure Inspections & Maintenance					
35.	Years 1-5	5	YR	$100,000	$500,000
36.	Years 6-30	1	LS	$290,000	$290,000
				Post-Closure Inspections & Maintenance Subtotal:	**$790,000**
Post-Closure Landfill Gas Monitoring & Reporting					
37.	Years 1-5	5	YR	$4,000	$20,000
38.	Years 6-30	1	LS	$24,000	$24,000
				Post-Closure Landfill Gas Monitoring & Reporting Subtotal:	**$44,000**
Post-Closure Groundwater Sampling & Reporting					
39.	Years 1-5	5	YR	$250,000	$1,250,000
40.	Years 6-30	1	LS	$1,500,000	$1,500,000
				Post-Closure Groundwater Sampling & Reporting:	**$2,750,000**
				O&M COST SUBTOTAL:	**$3,584,000**
				Contingency (20% of Subtotal O&M Cost):	**$716,800**
				TOTAL O&M COST:	**$4,300,800**
				TOTAL ESTIMATED COST:	**$19,939,175**
				ROUNDED TO:	**$19,900,000**

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General Notes:

A. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

B. Unit prices are based on 2009 dollars.

C. All volumes represent in-place measures.

D. Where not otherwise noted, unit cost is based on past project experience.

E. The total conceptual consolidation/cover system area is approximately 28 acres, subdivided as follows:

- 10 acres: Former Type III Landfill
- 12 acres: Western Disposal Area
- 6 acres: Monarch HRDL

F. The total area of PCB-containing soil (i.e., consolidation/cover system area as well as peripheral and outlying soil removal areas) is approximately 39 acres, subdivided as follows:

- 13.6 acres: Former Type III Landfill
- 15.6 acres: Western Disposal Area (including Panelyte Property, Panelyte Marsh, and Conrail Property)
- 6.8 acres: Monarch HRDL
- 1.8 acres: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
- 1.5 acres: Residential/MHLLC-Owned Properties (including Golden Age)

G. Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the site, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

H. "RS Means" refers to RS Means Heavy Construction Cost Data 2009.

I. "Aerial Photos" refers to images obtained from Microsoft® Live Search website (http://maps.live.com).

J. CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton WK=Week; MO=Month.

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Item Notes:

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking site features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during PCB-containing material handling only (e.g., excavation, consolidation, subgrade preparation), the duration of which is assumed to be approximately 10 months total. It is also assumed that 3 PCB PolyUrethane Foam (PUF) samples will be collected per day (i.e., one-sample up-wind and two down-wind samples). Air monitoring unit cost includes the preliminary estimated cost of the rental equipment ($260/day), analysis ($600 for 3 samples), shipping ($40/day), and labor ($300/day).

3. Temporary fence quantity represents the additional fencing needed to completely enclose and secure the various work areas. It is assumed that existing fence will be utilized, to the extent practicable.

4. Decontamination area is assumed to be an approximately 50-foot by 50-foot area, which consists of 18 inches of gravel underlain with a 40-mil high density polyethylene liner cushioned on both sides by a 12-ounce non-woven geotextile. Decontamination area is assumed to be sloped to a sump for collection of decontamination fluids.

5. Temporary access road unit cost is based on an assumed 1,900 foot-long, 24 foot-wide, 6-inch-thick gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600X). Gravel unit cost ($36/cubic yard) is based on a $17 per ton gravel cost (delivered), a 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard), and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600X) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

6. Clearing and grubbing unit cost is based on cutting and chipping of medium trees 12 to 18 inches in diameter and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system. Total clearing and grubbing area was estimated from aerial photos.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL. The estimated cost to drive, extract, and salvage the steel sheeting is estimated to be approximately $20 per square foot, based on RS Means. An additional $20,000 is included to account for the estimated total cost of installing an access road to facilitate sheeting installation with a crane.

8. Cost includes an assumed cost of $15,000 to upgrade the capacity of the existing water treatment system and a monthly maintenance cost of $5,000 to account for additional maintenance needs associated with construction activities.

9. Utility protection/relocation cost includes the estimated cost to relocate up to 7 electrical poles ($10,000/pole) around the removal and consolidation areas. In addition, the cost includes approximately $30,000 for the estimated expenses associated with relocation/replacement of miscellaneous on-site utilities (e.g., electrical line to the onsite water treatment facility, existing piping).

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10. Temporary stormwater management and erosion and sedimentation controls include temporary sediment controls (e.g., silt fence, haybales, filter socks, and stone check dams), miscellaneous water management (e.g., pumping of collected water to water treatment system, temporary piping/culverts), temporary seeding, and dust controls. In addition, unit cost includes maintenance costs for an approximately 2-year duration.

11. Well abandonment includes the abandonment of existing monitoring wells, piezometers, and seep wells located within the footprint of the conceptual consolidation and stormwater basin areas.

12. Survey cost includes stake-out activities associated with excavation, consolidation, construction, and confirmation sampling activities.

13. Soil removal and consolidation quantity represents the total quantity of in-situ material requiring excavation prior to consolidation within the Former Type III Landfill, Western Disposal Area, and Monarch HRDL consolidation areas. Soil removal and consolidation cost includes excavation and loading of PCB-containing materials, onsite transport to placement area within the consolidation areas, and placement and compaction in 12-inch lifts within the consolidation areas. Estimated quantities are based on removal and consolidation of approximately 190,000 cubic yards of material along the peripheral areas of the Former Type III Landfill and the Western Disposal Area (including the Panelyte Property, Panelyte Marsh, and Conrail Property), approximately 35,000 cubic yards of material along the peripheral area of the Monarch HRDL, and approximately 40,500 cubic yards of material from certain outlying areas (i.e., Golden Age, Residential Properties, MHLLC-Owned Property, Goodwill Lawn Area, and Consumers Power).

14. Confirmation sample quantity assumes that removal areas, located outside of the conceptual consolidation area (approximately 11 acres or 480,000 square feet), will be sampled on a 50 foot by 50 foot grid to confirm removal of PCB-containing material. Sampling costs are assumed to be the same as the costs for analyses (i.e., $180/sample for analysis; therefore, $180 x 2 = $360 for sampling and analysis).

15. Grade verification survey cost estimate includes two surveys of the consolidation/cover system areas. The first survey would be performed prior to commencing filling activities. The second survey would be performed immediately prior to the installation of the liner system (i.e., liner subgrade survey). Each survey is assumed to take approximately four weeks.

16. Soil grading layer cost estimate is based on an assumed 6-inch-thick layer of select fill covering the entire cover system areas and is the first layer of the earthen cover system. Select fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL

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17. Geotextile separation layer cost estimate assumes utilizing a non-woven geotextile covering the entire cover system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on information provided by geotextile manufacturer. Estimated quantities are subdivided as follows:

    - 58,100 square yards: Former Type III Landfill
    - 69,700 square yards: Western Disposal Area
    - 34,800 square yards: Monarch HRDL

18. Soil protection/drainage layer consists of a 1-foot-thick layer of sand covering the entire cover system area. Sand fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 16,150 cubic yards: Former Type III Landfill
    - 19,360 cubic yards: Western Disposal Area
    - 9,680 cubic yards: Monarch HRDL

19. Topsoil layer consists of a 6-inch-thick layer of topsoil covering the entire cover system areas. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement. Estimated quantities are subdivided as follows:

    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL

20. Seed and mulch cost estimate is based on seeding and mulching the entire area subject to consolidation/final cover system. The per acre unit cost is derived based on an estimated cost of $3,500/acre, which was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

21. Total length of the vegetated swale is based on a conceptual cover system layout prepared for cost estimating purposes only, and includes both perimeter swales/ditches and mid-slope swales. In addition, it is assumed that the linear foot unit cost to construct a perimeter swale is equal to the cost to construct a mid-slope swale. Vegetated swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and 2-foot-deep channel geometry. Vegetated swale unit cost includes the cost to excavate the swale ($2/cubic yard), install a 6-inch topsoil layer ($30/cubic yard), and cover with erosion control matting ($0.75/square yard). Seeding of vegetated swale is included in Item #20.

22. Total length of the riprap-lined swale is based on a conceptual cover system layout prepared for cost estimating purposes only. Riprap-lined swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and a 2-foot-deep channel geometry. Channel lining is assumed to consist of a 15-inch-thick layer of riprap underlain with a non-woven geotextile. Riprap-lined swale unit cost includes the cost to excavate the swale ($2/cubic yard), install the non-woven geotextile ($2.25/square yard), and install riprap ($100/cubic yard).

23. Riprap slope protection quantity is based on an assumed 40-foot-wide, 1,200-foot-long, by 15-inch-thick layer of riprap installed along the southeast bank of Portage Creek to protect the toe of the cover system side slope. Riprap material and placement cost is approximately $100 per cubic yard. Non-woven geotextile (i.e., Mirafi S800) unit cost ($2.25/square yard) is based on information provided by the manufacturer.

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Table 5-2 - Cost Estimate for Remedial Alternative 2B

24. Total length of culvert piping is based on a conceptual cover system layout prepared for cost estimating purposes only. Unit cost ($20/linear foot) is based on an assumed 18-inch diameter high density polyethylene (HDPE) pipe, Type S, and includes material and installation costs. Unit cost was obtained from RS Means.

25. It is anticipated that subsurface drainage would be installed at the interface between the consolidation area and the existing Bryant HRDLs and FRDLs liner system. Liner system grades at the interface are assumed to slope downward on a 4 on 1 slope forming a v-notch channel containing the subsurface drainage piping. Subsurface drainage is assumed to consist of a 6-inch diameter perforated pipe ($8.45 /linear foot) and a 6-inch-thick layer of drainage stone mounded over top the pipe ($61.50/cubic yard). In addition, the perforated pipe and drainage stone are wrapped in a non-woven geotextile ($2.25/square yard). Pipe and drainage stone unit costs were obtained from RS Means, and include material and installation costs. Additional geotextile material is assumed for a full-width overlap of each side of the geotextile in the longitudinal direction.

26. Stormwater basin unit cost represents an average per basin cost, which was developed from a conceptual stormwater basin configuration. Stormwater basin unit cost includes construction of an embankment (where applicable), topsoiling and seeding of the entire basin area, and construction of a corrugated metal pipe riser outlet structure. It is preliminarily assumed that a stormwater basin will be required for each of the Former Type III landfill, Western Disposal Area, and Monarch HRDL consolidation/cover system areas.

27. As-built survey consists of a detailed topographic and feature survey of the disturbed area. As-built survey cost includes both field and office support costs.

28. Estimated cost for backfill is partially based on calculation, as it provides for an estimate of the volume of clean fill material that will be required to backfill the peripheral soil removal areas associated with the Former Type III Landfill, Western Disposal Area, and Monarch HRDL to appropriate subgrade elevation. Actual volume to be determined during design phase. The estimated cost for backfill also assumes that the voids created by removal of PCB-containing soil from certain outlying areas (i.e., Golden Age, Residential Properties, MHLLC-Owned Property, Goodwill Lawn Area, and Consumers Power) will be replaced with clean backfill to within 6 inches of pre-existing grades (allowing for subsequent topsoil placement).

29. Topsoil quantity is based on covering approximately 11 acres of soil removal area, located outside the limits of capping, with 6 inches of topsoil. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement.

30. Seed and mulch quantity is based on covering the 11 acres of topsoil placed over the outlying soil removal areas, as necessary to promote vegetative growth. Unit cost (i.e., $3,500/acre) was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

31. Permanent access road quantity based on an assumed 7,600 linear feet of newly constructed road that will be required to access various portions of the cover system area for maintenance purposes. Permanent access roads are assumed to consist of a 24 foot-wide, 1-foot-thick, gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600x). Access road unit cost was based on a gravel material cost of $17 per ton (delivered), an assumed 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard) and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600x) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

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Table 5-2 - Cost Estimate for Remedial Alternative 2B

32. The estimated cost for installation of permanent gas probes is based on the assumption that a series of six permanent gas monitoring probes will be installed along perimeters of the Western Disposal Area and the Monarch HRDL to monitor landfill gas concentrations at locations adjacent to neighboring properties.

33. The estimated cost for installation of perimeter gas venting trenches is based on the assumption that 5-foot deep, 2-foot wide gas venting trenches, consisting of trenches filled with crushed stone/pea gravel and perforated piping affixed with wind turbine ventilators, will be installed along the perimeters of the Western Disposal Area and the Monarch HRDL to vent landfill gas from the subsurface before encroaching onto adjacent neighboring properties.

34. The estimated cost for installation of a post-closure groundwater monitoring network is based on the assumption that a series of groundwater monitoring wells will be installed along the entire perimeters of the Former Type III Landfill, the Western Disposal Area, and the Monarch HRDL for purposes of collecting post-closure groundwater samples.

35. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a quarterly basis for the first 5 years of the post-closure period.

36. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the net present value (NPV) or present worth, and is based on an annual cost of approximately $25,000 at a 7% discount rate.

37. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a quarterly basis for the first 5 years of the post-closure period.

38. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $2,000 at a 7% discount rate.

39. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a quarterly basis for the first 5 years of the post-closure period, and will include PCB and a variety of non-PCB constituents.

40. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period, and will include PCB and a variety of non-PCB constituents. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $125,000 at a 7% discount rate.

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Table 5-3 - Cost Estimate for Remedial Alternative 3A

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1.	Pre-Construction Field Survey	1	LS	$60,000	$60,000
2.	Air Monitoring Program	200	DAY	$1,200	$240,000
3.	Temporary Fencing	1	LS	$10,000	$10,000
4.	Decontamination Area	1	EA	$35,000	$35,000
5.	Temporary Construction Access Roads	1	LS	$100,000	$100,000
6.	Clearing & Grubbing	20	AC	$9,000	$180,000
7.	Temporary Steel Sheeting	1	LS	$410,000	$410,000
8.	Upgrade of Existing Water Treatment System and Monthly Maintenance Associated with Construction	1	LS	$95,000	$95,000
9.	Utility Protection / Relocation	1	LS	$100,000	$100,000
10.	Temporary Stormwater Management and Erosion and Sediment	1	LS	$420,000	$420,000
11.	Well Abandonment	18	EA	$500	$9,000
				Site Preparation Subtotal:	**$1,659,000**
Excavation and Consolidation					
12.	Survey	8	WK	$8,600	$68,800
13.	Soil Removal and Consolidation	225,000	CY	$10	$2,250,000
14.	Confirmation Sampling	140	EA	$360	$50,400
				Excavation and Consolidation Subtotal:	**$2,369,200**
Final Cover System					
15.	Grade Verification Surveys	8	WK	$8,600	$68,800
16.	Soil Grading Layer (Select Fill)	25,300	CY	$20	$506,000
17.	Geotextile Separation Layer (8-oz/sy)	181,800	SY	$2.25	$409,050
18.	Gas Venting Layer (Sand)	45,300	CY	$20	$906,000
19.	Passive Gas Vents	34	EA	$750	$25,200
20.	30-mil PVC Liner	135,500	SY	$6.40	$867,200
21.	Geotextile Cushion Layer (16-oz/sy)	162,600	SY	$4.25	$691,050
22.	Soil Protection / Drainage Layer (Sand)	101,000	CY	$20	$2,020,000
23.	Topsoil Layer	25,300	CY	$30	$759,000
24.	Seed & Mulch	31	AC	$3,500	$108,500
				Final Cover System Subtotal:	**$6,360,800**
Permanent Storm Water Management					
25.	Vegetated Swales	9,200	LF	$15	$138,000
26.	Riprap-Lined Swales	3,750	LF	$100	$375,000
27.	Riprap Slope Protection	1	LS	$370,000	$370,000
28.	Culverts	900	LF	$20	$18,000
29.	Subsurface Drain Piping	3,900	LF	$45	$175,500
30.	Stormwater Basins	3	EA	$60,000	$180,000
				Permanent Storm Water Management Subtotal:	**$1,256,500**
Restoration					
31.	As-Built Survey	6	WK	$8,600	$51,600
32.	Backfill	50,000	CY	$20	$1,000,000
33.	Topsoil	6,500	CY	$30	$195,000
34.	Seed & Mulch	8	AC	$3,500	$28,000
35.	Permanent Gravel Access Roads	1	LS	$275,000	$275,000
				Restoration Subtotal:	**$1,549,600**
Post-Closure Monitoring Features Installation					
36.	Installation of Permanent Gas Monitoring Probes	6	EA	$5,000	$30,000
37.	Installation of Perimeter Gas Venting Trenches	19,250	SF	$35	$673,750
38.	Installation of Post-Closure Groundwater Monitoring Well Network	20	EA	$5,000	$100,000
				Post-Closure Monitoring Features Installation Subtotal:	**$803,750**
				CAPITAL COST SUBTOTAL:	**$13,998,850**
				Mobilization/Demobilization (5% of Subtotal Capital Cost):	**$699,943**
				Administration, Engineering, and Construction Oversight (10% of Subtotal Capital Cost):	**$1,399,885**
				Independent Construction Quality Assurance (15% of Final Cover System Capital Costs):	**$954,120**
				Contingency (20% of Subtotal Capital Cost):	**$2,799,770**
				TOTAL CAPITAL COST:	**$19,852,568**

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Table 5-3 - Cost Estimate for Remedial Alternative 3A

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
II. OPERATION AND MAINTENANCE (O&M) COSTS					
Post-Closure Inspections & Maintenance					
39.	Years 1-5	5	YR	$100,000	$500,000
40.	Years 6-30	1	LS	$290,000	$290,000
				Post-Closure Inspections & Maintenance Subtotal:	**$790,000**
Post-Closure Landfill Gas Monitoring & Reporting					
41	Years 1-5	5	YR	$4,000	$20,000
42.	Years 6-30	1	LS	$24,000	$24,000
				Post-Closure Landfill Gas Monitoring & Reporting Subtotal:	**$44,000**
Post-Closure Groundwater Sampling & Reporting					
43.	Years 1-5	5	YR	$250,000	$1,250,000
44.	Years 6-30	1	LS	$1,500,000	$1,500,000
				Post-Closure Groundwater Sampling & Reporting:	**$2,750,000**
				O&M COST SUBTOTAL:	**$3,584,000**
				Contingency (20% of Subtotal O&M Cost):	**$716,800**
				TOTAL O&M COST:	**$4,300,800**
				TOTAL ESTIMATED COST:	**$24,153,368**
				ROUNDED TO:	**$24,200,000**

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Table 5-3 - Cost Estimate for Remedial Alternative 3A

General Notes:

A. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

B. Unit prices are based on 2009 dollars.

C. All volumes represent in-place measures.

D. Where not otherwise noted, unit cost is based on past project experience.

E. The total conceptual consolidation/cover system area is approximately 31 acres, subdivided as follows:

- 10 acres: Former Type III Landfill
- 12 acres: Western Disposal Area
- 6 acres: Monarch HRDL
- 1.8 acres: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
- 1.5 acres: Residential/MHLLC-Owned Properties (including Golden Age)

F. The total area of PCB-containing soil (i.e., consolidation/cover system area as well as peripheral and outlying soil removal areas) is approximately 39 acres, subdivided as follows:

- 13.6 acres: Former Type III Landfill
- 15.6 acres: Western Disposal Area (including Panelyte Property, Panelyte Marsh, and Conrail Property)
- 6.8 acres: Monarch HRDL
- 1.8 acres: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
- 1.5 acres: Residential/MHLLC-Owned Properties (including Golden Age)

G. Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the site, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

H. "RS Means" refers to RS Means Heavy Construction Cost Data 2009.

I. "Aerial Photos" refers to images obtained from Microsoft® Live Search website (http://maps.live.com).

J. CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton WK=Week; MO=Month.

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Table 5-3 - Cost Estimate for Remedial Alternative 3A

Item Notes:

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking site features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during PCB-containing material handling only (e.g., excavation, consolidation, subgrade preparation), the duration of which is assumed to be approximately 10 months total. It is also assumed that 3 PCB PolyUrethane Foam (PUF) samples will be collected per day (i.e., one-sample up-wind and two down-wind samples). Air monitoring unit cost includes the preliminary estimated cost of the rental equipment ($260/day), analysis ($600 for 3 samples), shipping ($40/day), and labor ($300/day).

3. Temporary fence quantity represents the additional fencing needed to completely enclose and secure the various work areas. It is assumed that existing fence will be utilized, to the extent practicable.

4. Decontamination area is assumed to be an approximately 50-foot by 50-foot area, which consists of 18 inches of gravel underlain with a 40-mil high density polyethylene liner cushioned on both sides by a 12-ounce non-woven geotextile. Decontamination area is assumed to be sloped to a sump for collection of decontamination fluids.

5. Temporary access road unit cost is based on an assumed 1,900 foot-long, 24 foot-wide, 6-inch-thick gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600X). Gravel unit cost ($36/cubic yard) is based on a $17 per ton gravel cost (delivered), a 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard), and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600X) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

6. Clearing and grubbing unit cost is based on cutting and chipping of medium trees 12 to 18 inches in diameter and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system. Total clearing and grubbing area was estimated from aerial photos.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL. The estimated cost to drive, extract, and salvage the steel sheeting is estimated to be approximately $20 per square foot, based on RS Means. An additional $20,000 is included to account for the estimated total cost of installing an access road to facilitate sheeting installation with a crane.

8. Cost includes an assumed cost of $15,000 to upgrade the capacity of the existing water treatment system and a monthly maintenance cost of $5,000 to account for additional maintenance needs associated with construction activities.

9. Utility protection/relocation cost includes the estimated cost to relocate up to 7 electrical poles ($10,000/pole) around the removal and consolidation areas. In addition, the cost includes approximately $30,000 for the estimated expenses associated with relocation/replacement of miscellaneous on-site utilities (e.g., electrical line to the onsite water treatment facility, existing piping).

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10. Temporary stormwater management and erosion and sedimentation controls include temporary sediment controls (e.g., silt fence, haybales, filter socks, and stone check dams), miscellaneous water management (e.g., pumping of collected water to water treatment system, temporary piping/culverts), temporary seeding, and dust controls. In addition, unit cost includes maintenance costs for an approximately 2-year duration.

11. Well abandonment includes the abandonment of existing monitoring wells, piezometers, and seep wells located within the footprint of the conceptual consolidation and stormwater basin areas.

12. Survey cost includes stake-out activities associated with excavation, consolidation, construction, and confirmation sampling activities.

13. Soil removal and consolidation quantity represents the total quantity of in-situ material requiring excavation prior to consolidation within the Former Type III Landfill, Western Disposal Area, and Monarch HRDL consolidation areas. Soil removal and consolidation cost includes excavation and loading of PCB-containing materials, onsite transport to placement area within the consolidation areas, and placement and compaction in 12-inch lifts within the consolidation areas. Estimated quantities are based on removal and consolidation of approximately 190,000 cubic yards of material along the peripheral areas of the Former Type III Landfill and the Western Disposal Area (including the Panelyte Property, Panelyte Marsh, and Conrail Property), and approximately 35,000 cubic yards of material along the peripheral area of the Monarch HRDL.

14. Confirmation sample quantity assumes that removal areas, located outside of the conceptual consolidation area (approximately 8 acres or 350,000 square feet), will be sampled on a 50 foot by 50 foot grid to confirm removal of PCB-containing material. Sampling costs are assumed to be the same as the costs for analyses (i.e., $180/sample for analysis; therefore, $180 x 2 = $360 for sampling and analysis).

15. Grade verification survey cost estimate includes two surveys of the consolidation/cover system areas. The first survey would be performed prior to commencing filling activities. The second survey would be performed immediately prior to the installation of the liner system (i.e., liner subgrade survey). Each survey is assumed to take approximately four weeks.

16. Soil grading layer cost estimate is based on an assumed 6-inch-thick layer of select fill covering the entire consolidation/cover system areas and is the first layer of the earthen cover/impermeable final cover system. Select fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL
    - 1,500 cubic yards: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
    - 1,200 cubic yards: Residential/MHLLC Properties (including Golden Age)

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Table 5-3 - Cost Estimate for Remedial Alternative 3A

17. Geotextile separation layer cost estimate assumes utilizing a non-woven geotextile covering the entire cover system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on information provided by geotextile manufacturer. Estimated quantities are subdivided as follows:

    - 58,100 square yards: Former Type III Landfill
    - 69,700 square yards: Western Disposal Area
    - 34,800 square yards: Monarch HRDL
    - 10,500 square yards: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
    - 8,700 square yards: Residential/MHLLC Properties (including Golden Age)

18. Estimated cost for gas venting layer is based on the assumption that a 12-inch sand layer will be placed on top of the geotextile separation layer of the Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas only, as these areas will consist of an impermeable cover system.

19. Estimated cost for passive gas vent installation is based on an installation frequency of 1.2 vents/acre within the Former Type III Landfill, the Western Disposal Area, and the Monarch HRDL areas only, as these areas will consist of an impermeable cover system.

20. Estimated cost for 30-mil PVC liner is based on the assumption that an impermeable liner will be placed over the 12-inch sand layer of the Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas only, as these areas will consist of an impermeable cover system.

21. Estimated cost for installation of geotextile cushion layer (16 oz) is based on the assumption that a geotextile layer will be placed over the 30-mil PVC liner in the Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas only, as these areas will consist of an impermeable cover system. The estimated quantity includes an additional 20% material quantity to account for overlap and wrinkles.

22. Soil protection/drainage layer consists of a 2-foot-thick layer of sand covering the entire cover system area. Sand fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 32,300 cubic yards: Former Type III Landfill
    - 38,700 cubic yards: Western Disposal Area
    - 19,400 cubic yards: Monarch HRDL
    - 5,800 cubic yards: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
    - 4,800 cubic yards: Residential/MHLLC Properties (including Golden Age)

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Table 5-3 - Cost Estimate for Remedial Alternative 3A

23. Topsoil layer consists of a 6-inch-thick layer of topsoil covering the entire cover system areas. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement. Estimated quantities are subdivided as follows:

    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL
    - 1,500 cubic yards: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
    - 1,200 cubic yards: Residential/MHLLC Properties (including Golden Age)

24. Seed and mulch cost estimate is based on seeding and mulching the entire area subject to consolidation/final cover system. The per acre unit cost is derived based on an estimated cost of $3,500/acre, which was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

25. Total length of the vegetated swale is based on a conceptual cover system layout prepared for cost estimating purposes only, and includes both perimeter swales/ditches and mid-slope swales. In addition, it is assumed that the linear foot unit cost to construct a perimeter swale is equal to the cost to construct a mid-slope swale. Vegetated swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and 2-foot-deep channel geometry. Vegetated swale unit cost includes the cost to excavate the swale ($2/cubic yard), install a 6-inch topsoil layer ($30/cubic yard), and cover with erosion control matting ($0.75/square yard). Seeding of vegetated swale is included in Item #20.

26. Total length of the riprap-lined swale is based on a conceptual cover system layout prepared for cost estimating purposes only. Riprap-lined swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and a 2-foot-deep channel geometry. Channel lining is assumed to consist of a 15-inch-thick layer of riprap underlain with a non-woven geotextile. Riprap-lined swale unit cost includes the cost to excavate the swale ($2/cubic yard), install the non-woven geotextile ($2.25/square yard), and install riprap ($100/cubic yard).

27. Riprap slope protection quantity is based on an assumed 40-foot-wide, 1,200-foot-long, by 15-inch-thick layer of riprap installed along the southeast bank of Portage Creek to protect the toe of the cover system side slope. Riprap material and placement cost is approximately $100 per cubic yard. Non-woven geotextile (i.e., Mirafi S800) unit cost ($2.25/square yard) is based on information provided by the manufacturer.

28. Total length of culvert piping is based on a conceptual cover system layout prepared for cost estimating purposes only. Unit cost ($20/linear foot) is based on an assumed 18-inch diameter high density polyethylene (HDPE) pipe, Type S, and includes material and installation costs. Unit cost was obtained from RS Means.

29. It is anticipated that subsurface drainage would be installed at the interface between the consolidation area and the existing Bryant HRDLs and FRDLs liner system. Liner system grades at the interface are assumed to slope downward on a 4 on 1 slope forming a v-notch channel containing the subsurface drainage piping. Subsurface drainage is assumed to consist of a 6-inch diameter perforated pipe ($8.45 /linear foot) and a 6-inch-thick layer of drainage stone mounded over top the pipe ($61.50/cubic yard). In addition, the perforated pipe and drainage stone are wrapped in a non-woven geotextile ($2.25/square yard). Pipe and drainage stone unit costs were obtained from RS Means, and include material and installation costs. Additional geotextile material is assumed for a full-width overlap of each side of the geotextile in the longitudinal direction.

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Table 5-3 - Cost Estimate for Remedial Alternative 3A

30. Stormwater basin unit cost represents an average per basin cost, which was developed from a conceptual stormwater basin configuration. Stormwater basin unit cost includes construction of an embankment (where applicable), topsoiling and seeding of the entire basin area, and construction of a corrugated metal pipe riser outlet structure. It is preliminarily assumed that a stormwater basin will be required for each of the Former Type III landfill, Western Disposal Area, and Monarch HRDL consolidation/cover system areas.

31. As-built survey consists of a detailed topographic and feature survey of the disturbed area. As-built survey cost includes both field and office support costs.

32. Estimated cost for backfill is not based on calculation, rather it is an estimate of the volume of clean fill material that will be required to backfill the peripheral soil removal areas associated with the Former Type III Landfill, Western Disposal Area, and Monarch HRDL to appropriate subgrade elevation. Actual volume to be determined during design phase.

33. Topsoil quantity is based on covering approximately 8 acres of soil removal area, located outside the limits of capping, with 6 inches of topsoil. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement.

34. Seed and mulch quantity is based on covering the 8 acres of topsoil placed over the outlying soil removal areas, as necessary to promote vegetative growth. Unit cost (i.e., $3,500/acre) was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

35. Permanent access road quantity based on an assumed 7,600 linear feet of newly constructed road that will be required to access various portions of the cover system area for maintenance purposes. Permanent access roads are assumed to consist of a 24 foot-wide, 1-foot-thick, gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600x). Access road unit cost was based on a gravel material cost of $17 per ton (delivered), an assumed 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard) and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600x) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

36. The estimated cost for installation of permanent gas probes is based on the assumption that a series of six permanent gas monitoring probes will be installed along perimeters of the Western Disposal Area and the Monarch HRDL to monitor landfill gas concentrations at locations adjacent to neighboring properties.

37. The estimated cost for installation of perimeter gas venting trenches is based on the assumption that 5-foot deep, 2-foot wide gas venting trenches, consisting of trenches filled with crushed stone/pea gravel and perforated piping affixed with wind turbine ventilators, will be installed along the perimeters of the Western Disposal Area and the Monarch HRDL to vent landfill gas from the subsurface before encroaching onto adjacent neighboring properties.

38. The estimated cost for installation of a post-closure groundwater monitoring network is based on the assumption that a series of groundwater monitoring wells will be installed along the entire perimeters of the Former Type III Landfill, the Western Disposal Area, and the Monarch HRDL for purposes of collecting post-closure groundwater samples.

39. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a quarterly basis for the first 5 years of the post-closure period.

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Table 5-3 - Cost Estimate for Remedial Alternative 3A

40. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the net present value (NPV) or present worth, and is based on an annual cost of approximately $25,000 at a 7% discount rate.

41. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a quarterly basis for the first 5 years of the post-closure period.

42. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $2,000 at a 7% discount rate.

43. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a quarterly basis for the first 5 years of the post-closure period, and will include PCB and a variety of non-PCB constituents.

44. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period, and will include PCB and a variety of non-PCB constituents. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $125,000 at a 7% discount rate.

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Table 5-4 - Cost Estimate for Remedial Alternative 3B

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1.	Pre-Construction Field Survey	1	LS	$60,000	$60,000
2.	Air Monitoring Program	280	DAY	$1,200	$336,000
3.	Temporary Fencing	1	LS	$10,000	$10,000
4.	Decontamination Area	1	EA	$35,000	$35,000
5.	Temporary Construction Access Roads	1	LS	$100,000	$100,000
6.	Clearing & Grubbing	20	AC	$9,000	$180,000
7.	Temporary Steel Sheeting	1	LS	$2,160,000	$2,160,000
8.	Upgrade of Existing Water Treatment System and Monthly Maintenance Associated with Construction	1	LS	$95,000	$95,000
9.	Utility Protection / Relocation	1	LS	$100,000	$100,000
10.	Temporary Stormwater Management and Erosion and Sediment	1	LS	$420,000	$420,000
11.	Well Abandonment	18	EA	$500	$9,000
				Site Preparation Subtotal:	**$3,505,000**
Excavation and Consolidation					
12.	Survey	10	WK	$8,600	$86,000
13.	Soil Removal and Consolidation	316,000	CY	$10	$3,160,000
14.	Confirmation Sampling	244	EA	$360	$87,840
				Excavation and Consolidation Subtotal:	**$3,333,840**
Final Cover System					
15.	Grade Verification Surveys	8	WK	$8,600	$68,800
16.	Soil Grading Layer (Select Fill)	22,600	CY	$20	$452,000
17.	Geotextile Separation Layer (8-oz/sy)	162,600	SY	$2.25	$365,850
18.	Gas Venting Layer (Sand)	45,300	CY	$20	$906,000
19.	Passive Gas Vents	34	EA	$750	$25,200
20.	30-mil PVC Liner	135,500	SY	$6.40	$867,200
21.	Geotextile Cushion Layer (16-oz/sy)	162,600	SY	$4.25	$691,050
22.	Soil Protection / Drainage Layer (Sand)	90,400	CY	$20	$1,808,000
23.	Topsoil Layer	22,600	CY	$30	$678,000
24.	Seed & Mulch	28	AC	$3,500	$98,000
				Final Cover System Subtotal:	**$5,960,100**
Permanent Storm Water Management					
25.	Vegetated Swales	9,200	LF	$15	$138,000
26.	Riprap-Lined Swales	3,750	LF	$100	$375,000
27.	Riprap Slope Protection	1	LS	$370,000	$370,000
28.	Culverts	900	LF	$20	$18,000
29.	Subsurface Drain Piping	3,900	LF	$45	$175,500
30.	Stormwater Basins	3	EA	$60,000	$180,000
				Permanent Storm Water Management Subtotal:	**$1,256,500**
Restoration					
31.	As-Built Survey	6	WK	$8,600	$51,600
32.	Backfill	137,000	CY	$20	$2,740,000
33.	Topsoil	11,300	CY	$30	$339,000
34.	Seed & Mulch	14	AC	$3,500	$49,000
35.	Permanent Gravel Access Roads	1	LS	$275,000	$275,000
				Restoration Subtotal:	**$3,454,600**
Post-Closure Monitoring Features Installation					
36.	Installation of Permanent Gas Monitoring Probes	6	EA	$5,000	$30,000
37.	Installation of Perimeter Gas Venting Trenches	19,250	SF	$35	$673,750
38.	Installation of Post-Closure Groundwater Monitoring Well Network	20	EA	$5,000	$100,000
				Post-Closure Monitoring Features Installation Subtotal:	**$803,750**
				CAPITAL COST SUBTOTAL:	**$18,313,790**
				Mobilization/Demobilization (5% of Subtotal Capital Cost):	**$915,690**
				Administration, Engineering, and Construction Oversight (10% of Subtotal Capital Cost):	**$1,831,379**
				Independent Construction Quality Assurance (15% of Final Cover System Capital Costs):	**$894,015**
				Contingency (20% of Subtotal Capital Cost):	**$3,662,758**
				TOTAL CAPITAL COST:	**$25,617,632**

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Table 5-4 - Cost Estimate for Remedial Alternative 3B

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
II. OPERATION AND MAINTENANCE (O&M) COSTS					
Post-Closure Inspections & Maintenance					
39.	Years 1-5	5	YR	$100,000	$500,000
40.	Years 6-30	1	LS	$290,000	$290,000
				Post-Closure Inspections & Maintenance Subtotal:	**$790,000**
Post-Closure Landfill Gas Monitoring & Reporting					
41.	Years 1-5	5	YR	$4,000	$20,000
42.	Years 6-30	1	LS	$24,000	$24,000
				Post-Closure Landfill Gas Monitoring & Reporting Subtotal:	**$44,000**
Post-Closure Groundwater Sampling & Reporting					
43.	Years 1-5	5	YR	$250,000	$1,250,000
44.	Years 6-30	1	LS	$1,500,000	$1,500,000
				Post-Closure Groundwater Sampling & Reporting:	**$2,750,000**
				O&M COST SUBTOTAL:	**$3,584,000**
				Contingency (20% of Subtotal O&M Cost):	**$716,800**
				TOTAL O&M COST:	**$4,300,800**
				TOTAL ESTIMATED COST:	**$29,918,432**
				ROUNDED TO:	**$29,900,000**

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Table 5-4- Cost Estimate for Remedial Alternative 3B

General Notes:

A. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

B. Unit prices are based on 2009 dollars.

C. All volumes represent in-place measures.

D. Where not otherwise noted, unit cost is based on past project experience.

E. The total conceptual consolidation/cover system area is approximately 28 acres, subdivided as follows:

- 10 acres: Former Type III Landfill
- 12 acres: Western Disposal Area
- 6 acres: Monarch HRDL

F. The total area of PCB-containing soil (i.e., consolidation/cover system area as well as peripheral and outlying soil removal areas) is approximately 42 acres, subdivided as follows:

- 13.6 acres: Former Type III Landfill
- 15.6 acres: Western Disposal Area (including Panelyte Property, Panelyte Marsh, and Conrail Property)
- 6.8 acres: Monarch HRDL
- 4.8 acres: Commercial Properties (i.e., Goodwill Parking Lots, Goodwill Lawn Area, Consumers Power, and Alcott Street Parking Lot)
- 1.5 acres: Residential/MHLLC-Owned Properties (including Golden Age)

G. Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the site, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

H. "RS Means" refers to RS Means Heavy Construction Cost Data 2009.

I. "Aerial Photos" refers to images obtained from Microsoft® Live Search website (http://maps.live.com).

J. CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton WK=Week; MO=Month.

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Table 5-4- Cost Estimate for Remedial Alternative 3B

Item Notes:

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking OU features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during PCB-containing material handling only (e.g., excavation, consolidation, subgrade preparation), the duration of which is assumed to be approximately 14 months total. It is also assumed that 3 PCB PolyUrethane Foam (PUF) samples will be collected per day (i.e., one-sample up-wind and two down-wind samples). Air monitoring unit cost includes the preliminary estimated cost of the rental equipment ($260/day), analysis ($600 for 3 samples), shipping ($40/day), and labor ($300/day).

3. Temporary fence quantity represents the additional fencing needed to completely enclose and secure the various work areas. It is assumed that existing fence will be utilized, to the extent practicable.

4. Decontamination area is assumed to be an approximately 50-foot by 50-foot area, which consists of 18 inches of gravel underlain with a 40-mil high density polyethylene liner cushioned on both sides by a 12-ounce non-woven geotextile. Decontamination area is assumed to be sloped to a sump for collection of decontamination fluids.

5. Temporary access road unit cost is based on an assumed 1,900 foot-long, 24 foot-wide, 6-inch-thick gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600X). Gravel unit cost ($36/cubic yard) is based on a $17 per ton gravel cost (delivered), a 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard), and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600X) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

6. Clearing and grubbing unit cost is based on cutting and chipping of medium trees 12 to 18 inches in diameter and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system. Total clearing and grubbing area was estimated from aerial photos.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL. The estimated cost to drive, extract, and salvage the steel sheeting is estimated to be approximately $20 per square foot, based on RS Means. An additional $20,000 is included to account for the estimated total cost of installing an access road to facilitate sheeting installation with a crane. This line item also includes approximately $1,750,000 of temporary steel sheeting to facilitate soil removal activities within the Goodwill and Alcott Street Parking Lot areas. Given the anticipated depth of excavation in this area (i.e., 20 feet below ground surface) combined with the proximity of the building adjacent to the Goodwill Parking Lots, sheeting will likely be required. Special methods will also be required to drive the sheets while minimizing the potential for damage to the adjacent structure (e.g., trenching and pre-drilling, pile driving using low vibratory methods, crack, vibration, and settlement monitoring). Estimated cost is based on approximately 35,000 square feet of sheeting at $50 per square foot to procure, install, and extract the sheet piles.
8. Cost includes an assumed cost of $15,000 to upgrade the capacity of the existing water treatment system and a monthly maintenance cost of $5,000 to account for additional maintenance needs associated with construction activities.

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<u>Table 5-4- Cost Estimate for Remedial Alternative 3B</u>

9. Utility protection/relocation cost includes the estimated cost to relocate up to 7 electrical poles ($10,000/pole) around the removal and consolidation areas. In addition, the cost includes approximately $30,000 for the estimated expenses associated with relocation/replacement of miscellaneous onsite utilities (e.g., electrical line to the onsite water treatment facility, existing piping).

10. Temporary stormwater management and erosion and sedimentation controls include temporary sediment controls (e.g., silt fence, haybales, filter socks, and stone check dams), miscellaneous water management (e.g., pumping of collected water to water treatment system, temporary piping/culverts), temporary seeding, and dust controls. In addition, unit cost includes maintenance costs for an approximately 2-year duration.

11. Well abandonment includes the abandonment of existing monitoring wells, piezometers, and seep wells located within the footprint of the conceptual consolidation and stormwater basin areas.

12. Survey cost includes stake-out activities associated with excavation, consolidation, construction, and confirmation sampling activities.

13. Soil removal and consolidation quantity represents the total quantity of in-situ material requiring excavation prior to consolidation within the Former Type III Landfill, Western Disposal Area, and Monarch HRDL consolidation areas. Soil removal and consolidation cost includes excavation and loading of PCB-containing materials, onsite transport to placement area within the consolidation areas, and placement and compaction in 12-inch lifts within the consolidation areas. Estimated quantities are based on removal and consolidation of approximately 190,000 cubic yards of material along the peripheral areas of the Former Type III Landfill and the Western Disposal Area (including the Panelyte Property, Panelyte Marsh, and Conrail Property), approximately 35,000 cubic yards of material along the peripheral area of the Monarch HRDL, and approximately 91,000 cubic yards of material from certain outlying areas (i.e., Golden Age, Residential Properties, MHLLC-Owned Property, Consumers Power, Goodwill Lawn Area, Goodwill Parking Lots, and Alcott Street Parking Lot).

14. Confirmation sample quantity assumes that removal areas, located outside of the conceptual consolidation area (approximately 14 acres or 610,000 square feet), will be sampled on a 50 foot by 50 foot grid to confirm removal of PCB-containing material. Sampling costs are assumed to be the same as the costs for analyses (i.e., $180/sample for analysis; therefore, $180 x 2 = $360 for sampling and analysis).

15. Grade verification survey cost estimate includes two surveys of the consolidation/cover system areas. The first survey would be performed prior to commencing filling activities. The second survey would be performed immediately prior to the installation of the liner system (i.e., liner subgrade survey). Each survey is assumed to take approximately four weeks.

16. Soil grading layer cost estimate is based on an assumed 6-inch-thick layer of select fill covering the entire cover system areas and is the first layer of the impermeable final cover system. Select fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL

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Table 5-4- Cost Estimate for Remedial Alternative 3B

17. Geotextile separation layer cost estimate assumes utilizing a non-woven geotextile covering the entire cover system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on information provided by geotextile manufacturer. Estimated quantities are subdivided as follows:

    - 58,100 square yards: Former Type III Landfill
    - 69,700 square yards: Western Disposal Area
    - 34,800 square yards: Monarch HRDL

18. Estimated cost for gas venting layer is based on the assumption that a 12-inch sand layer will be placed on top of the geotextile separation layer of the Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas only, as these areas will consist of an impermeable cover system.

19. Estimated cost for passive gas vent installation is based on an installation frequency of 1.2 vents/acre within the Former Type III Landfill, the Western Disposal Area, and the Monarch HRDL areas only, as these areas will consist of an impermeable cover system.

20. Estimated cost for 30-mil PVC liner is based on the assumption that an impermeable liner will be placed over the 12-inch sand layer of the Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas only, as these areas will consist of an impermeable cover system.

21. Estimated cost for installation of geotextile cushion layer (16 oz) is based on the assumption that a geotextile layer will be placed over the 30-mil PVC liner in the Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas only, as these areas will consist of an impermeable cover system. The estimated quantity includes an additional 20% material quantity to account for overlap and wrinkles.

22. Soil protection/drainage layer consists of a 2-foot-thick layer of sand covering the entire cover system area. Sand fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 32,400 cubic yards: Former Type III Landfill
    - 38,800 cubic yards: Western Disposal Area
    - 19,200 cubic yards: Monarch HRDL

23. Topsoil layer consists of a 6-inch-thick layer of topsoil covering the entire cover system areas. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement. Estimated quantities are subdivided as follows:

    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL

24. Seed and mulch cost estimate is based on seeding and mulching the entire area subject to consolidation/final cover system. The per acre unit cost is derived based on an estimated cost of $3,500/acre, which was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

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Table 5-4- Cost Estimate for Remedial Alternative 3B

25. Total length of the vegetated swale is based on a conceptual cover system layout prepared for cost estimating purposes only, and includes both perimeter swales/ditches and mid-slope swales. In addition, it is assumed that the linear foot unit cost to construct a perimeter swale is equal to the cost to construct a mid-slope swale. Vegetated swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and 2-foot-deep channel geometry. Vegetated swale unit cost includes the cost to excavate the swale ($2/cubic yard), install a 6-inch topsoil layer ($30/cubic yard), and cover with erosion control matting ($0.75/square yard).

26. Total length of the riprap-lined swale is based on a conceptual cover system layout prepared for cost estimating purposes only. Riprap-lined swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and a 2-foot-deep channel geometry. Channel lining is assumed to consist of a 15-inch-thick layer of riprap underlain with a non-woven geotextile. Riprap-lined swale unit cost includes the cost to excavate the swale ($2/cubic yard), install the non-woven geotextile ($2.25/square yard), and install riprap ($100/cubic yard).

27. Riprap slope protection quantity is based on an assumed 40-foot-wide, 1,200-foot-long, by 15-inch-thick layer of riprap installed along the southeast bank of Portage Creek to protect the toe of the cover system side slope. Riprap material and placement cost is approximately $100 per cubic yard. Non-woven geotextile (i.e., Mirafi S800) unit cost ($2.25/square yard) is based on information provided by the manufacturer.

28. Total length of culvert piping is based on a conceptual cover system layout prepared for cost estimating purposes only. Unit cost ($20/linear foot) is based on an assumed 18-inch diameter high density polyethylene (HDPE) pipe, Type S, and includes material and installation costs. Unit cost was obtained from RS Means.

29. It is anticipated that subsurface drainage would be installed at the interface between the consolidation area and the existing Bryant HRDLs and FRDLs liner system. Liner system grades at the interface are assumed to slope downward on a 4 on 1 slope forming a v-notch channel containing the subsurface drainage piping. Subsurface drainage is assumed to consist of a 6-inch diameter perforated pipe ($8.45 /linear foot) and a 6-inch-thick layer of drainage stone mounded over top the pipe ($61.50/cubic yard). In addition, the perforated pipe and drainage stone are wrapped in a non-woven geotextile ($2.25/square yard). Pipe and drainage stone unit costs were obtained from RS Means, and include material and installation costs. Additional geotextile material is assumed for a full-width overlap of each side of the geotextile in the longitudinal direction.

30. Stormwater basin unit cost represents an average per basin cost, which was developed from a conceptual stormwater basin configuration. Stormwater basin unit cost includes construction of an embankment (where applicable), topsoiling and seeding of the entire basin area, and construction of a corrugated metal pipe riser outlet structure. It is preliminarily assumed that a stormwater basin will be required for each of the Former Type III landfill, Western Disposal Area, and Monarch HRDL consolidation/cover system areas.

31. As-built survey consists of a detailed topographic and feature survey of the disturbed area. As-built survey cost includes both field and office support costs.

32. Estimated cost for backfill is partially based on calculation, as it provides for an estimate of the volume of clean fill material that will be required to backfill the peripheral soil removal areas associated with the Former Type III Landfill, Western Disposal Area, and Monarch HRDL to appropriate subgrade elevation. Actual volume to be determined during design phase. The estimated cost for backfill also assumes that the voids created by removal of PCB-containing soil from certain outlying areas (i.e., Golden Age, Residential Properties, MHLLC-Owned Property, Goodwill Lawn Area, Goodwill Parking Lots, Consumers Power, and Alcott Street Parking Lot) will be replaced with clean backfill to within 6 inches of pre-existing grades (allowing for subsequent topsoil placement).

Table 5-4- Cost Estimate for Remedial Alternative 3B

33. Topsoil quantity is based on covering approximately 14 acres of soil removal area, located outside the limits of capping, with 6 inches of topsoil. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement.

34. Seed and mulch quantity is based on covering the 14 acres of topsoil placed over the outlying soil removal areas, as necessary to promote vegetative growth. Unit cost (i.e., $3,500/acre) was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

35. Permanent access road quantity based on an assumed 7,600 linear feet of newly constructed road that will be required to access various portions of the cover system area for maintenance purposes. Permanent access roads are assumed to consist of a 24 foot-wide, 1-foot-thick, gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600x). Access road unit cost was based on a gravel material cost of $17 per ton (delivered), an assumed 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard) and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600x) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

36. The estimated cost for installation of permanent gas probes is based on the assumption that a series of six permanent gas monitoring probes will be installed along perimeters of the Western Disposal Area and the Monarch HRDL to monitor landfill gas concentrations at locations adjacent to neighboring properties.

37. The estimated cost for installation of perimeter gas venting trenches is based on the assumption that 5-foot deep, 2-foot wide gas venting trenches, consisting of trenches filled with crushed stone/pea gravel and perforated piping affixed with wind turbine ventilators, will be installed along the perimeters of the Western Disposal Area and the Monarch HRDL to vent landfill gas from the subsurface before encroaching onto adjacent neighboring properties.

38. The estimated cost for installation of a post-closure groundwater monitoring network is based on the assumption that a series of groundwater monitoring wells will be installed along the entire perimeters of the Former Type III Landfill, the Western Disposal Area, and the Monarch HRDL for purposes of collecting post-closure groundwater samples.

39. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a quarterly basis for the first 5 years of the post-closure period.

40. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the net present value (NPV) or present worth, and is based on an annual cost of approximately $25,000 at a 7% discount rate.

41. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a quarterly basis for the first 5 years of the post-closure period.

42. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $2,000 at a 7% discount rate.

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Table 5-4- Cost Estimate for Remedial Alternative 3B

43. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a quarterly basis for the first 5 years of the post-closure period, and will include PCB and a variety of non-PCB constituents.

44. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period, and will include PCB and a variety of non-PCB constituents. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $125,000 at a 7% discount rate.

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Table 5-5 - Cost Estimate for Remedial Alternative 4A

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1.	Pre-Construction Field Survey	1	LS	$60,000	$60,000
2.	Air Monitoring Program	200	DAY	$1,200	$240,000
3.	Temporary Fencing	1	LS	$10,000	$10,000
4.	Decontamination Area	1	EA	$35,000	$35,000
5.	Temporary Construction Access Roads	1	LS	$100,000	$100,000
6.	Clearing & Grubbing	20	AC	$9,000	$180,000
7.	Temporary Steel Sheeting	1	LS	$410,000	$410,000
8.	Upgrade of Existing Water Treatment System and Monthly Maintenance Associated with Construction	1	LS	$95,000	$95,000
9.	Utility Protection / Relocation	1	LS	$100,000	$100,000
10.	Temporary Stormwater Management and Erosion and Sediment	1	LS	$420,000	$420,000
11.	Well Abandonment	18	EA	$500	$9,000
				Site Preparation Subtotal:	**$1,659,000**
Excavation and Consolidation					
12.	Survey	8	WK	$8,600	$68,800
13.	Soil Removal & Consolidation	225,000	CY	$10	$2,250,000
14.	Soil Removal & Processing/Loading into Disposal Containers	40,500	CY	$8	$324,000
15.	Confirmation Sampling	192	EA	$360	$69,120
				Excavation and Consolidation Subtotal:	**$2,711,920**
Offsite Transportation & Disposal					
16.	Offsite Transportation & Disposal - Non-TSCA	64,800	TN	$30	$1,944,000
				Offsite Transportation & Disposal Subtotal:	**$1,944,000**
Final Cover System					
17.	Grade Verification Surveys	8	WK	$8,600	$68,800
18.	Soil Grading Layer (Select Fill)	22,600	CY	$20	$452,000
19.	Geotextile Separation Layer (8-oz/sy)	162,600	SY	$2.25	$365,850
20.	Gas Venting Layer (Sand)	45,300	CY	$20	$906,000
21.	Passive Gas Vents	34	EA	$750	$25,200
22.	30-mil PVC Liner	135,500	SY	$6.40	$867,200
23.	Geotextile Cushion Layer (16-oz/sy)	162,600	SY	$4.25	$691,050
24.	Soil Protection / Drainage Layer (Sand)	90,400	CY	$20	$1,808,000
25.	Topsoil Layer	22,600	CY	$30	$678,000
26.	Seed & Mulch	28	AC	$3,500	$98,000
				Final Cover System Subtotal:	**$5,960,100**
Permanent Storm Water Management					
27.	Vegetated Swales	9,200	LF	$15	$138,000
28.	Riprap-Lined Swales	3,750	LF	$100	$375,000
29.	Riprap Slope Protection	1	LS	$370,000	$370,000
30.	Culverts	900	LF	$20	$18,000
31.	Subsurface Drain Piping	3,900	LF	$45	$175,500
32.	Stormwater Basins	3	EA	$60,000	$180,000
				Permanent Storm Water Management Subtotal:	**$1,256,500**
Restoration					
33.	As-Built Survey	6	WK	$8,600	$51,600
34.	Backfill	88,900	CY	$20	$1,778,000
35.	Topsoil	8,900	CY	$30	$267,000
36.	Seed & Mulch	11	AC	$3,500	$38,500
37.	Permanent Gravel Access Roads	1	LS	$275,000	$275,000
				Restoration Subtotal:	**$2,410,100**
Post-Closure Monitoring Features Installation					
38.	Installation of Permanent Gas Monitoring Probes	6	EA	$5,000	$30,000
39.	Installation of Perimeter Gas Venting Trenches	19,250	SF	$35	$673,750
40.	Installation of Post-Closure Groundwater Monitoring Well Network	20	EA	$5,000	$100,000
				Post-Closure Monitoring Features Installation Subtotal:	**$803,750**
				CAPITAL COST SUBTOTAL:	**$16,745,370**
				Mobilization/Demobilization (5% of Subtotal Capital Cost):	**$837,269**
				Administration, Engineering, and Construction Oversight (10% of Subtotal Capital Cost):	**$1,674,537**
				Independent Construction Quality Assurance (15% of Final Cover System Capital Costs):	**$894,015**
				Contingency (20% of Subtotal Capital Cost):	**$3,349,074**
				TOTAL CAPITAL COST:	**$23,500,265**

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Table 5-5 - Cost Estimate for Remedial Alternative 4A

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
II. OPERATION AND MAINTENANCE (O&M) COSTS					
Post-Closure Inspections & Maintenance					
41.	Years 1-5	5	YR	$100,000	$500,000
42.	Years 6-30	1	LS	$290,000	$290,000
				Post-Closure Inspections & Maintenance Subtotal:	**$790,000**
Post-Closure Landfill Gas Monitoring & Reporting					
43.	Years 1-5	5	YR	$4,000	$20,000
44.	Years 6-30	1	LS	$24,000	$24,000
				Post-Closure Landfill Gas Monitoring & Reporting Subtotal:	**$44,000**
Post-Closure Groundwater Sampling & Reporting					
45.	Years 1-5	5	YR	$250,000	$1,250,000
46.	Years 6-30	1	LS	$1,500,000	$1,500,000
				Post-Closure Groundwater Sampling & Reporting:	**$2,750,000**
				O&M COST SUBTOTAL:	**$3,584,000**
				Contingency (20% of Subtotal O&M Cost):	**$716,800**
				TOTAL O&M COST:	**$4,300,800**
				TOTAL ESTIMATED COST:	**$27,801,065**
				ROUNDED TO:	**$27,800,000**

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Table 5-5 - Cost Estimate for Remedial Alternative 4A

General Notes:

A. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

B. Unit prices are based on 2009 dollars.

C. All volumes represent in-place measures.

D. Where not otherwise noted, unit cost is based on past project experience.

E. The total conceptual consolidation/cover system area is approximately 28 acres, subdivided as follows:

- 10 acres: Former Type III Landfill
- 12 acres: Western Disposal Area
- 6 acres: Monarch HRDL

F. The total area of PCB-containing soil (i.e., consolidation/cover system area as well as peripheral and outlying soil removal areas) is approximately 39 acres, subdivided as follows:

- 13.6 acres: Former Type III Landfill
- 15.6 acres: Western Disposal Area (including Panelyte Property, Panelyte Marsh, and Conrail Property)
- 6.8 acres: Monarch HRDL
- 1.8 acres: Commercial Properties (Goodwill Lawn Area and Consumers Power only)
- 1.5 acres: Residential/MHLLC-Owned Properties (including Golden Age)

G. Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

H. "RS Means" refers to RS Means Heavy Construction Cost Data 2009.

I. "Aerial Photos" refers to images obtained from Microsoft® Live Search website (http://maps.live.com).

J. CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton WK=Week; MO=Month.

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Table 5-5 - Cost Estimate for Remedial Alternative 4A

Item Notes:

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking OU features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during PCB-containing material handling only (e.g., excavation, consolidation, subgrade preparation), the duration of which is assumed to be approximately 10 months total. It is also assumed that 3 PCB PolyUrethane Foam (PUF) samples will be collected per day (i.e., one-sample up-wind and two down-wind samples). Air monitoring unit cost includes the preliminary estimated cost of the rental equipment ($260/day), analysis ($600 for 3 samples), shipping ($40/day), and labor ($300/day).

3. Temporary fence quantity represents the additional fencing needed to completely enclose and secure the various work areas. It is assumed that existing fence will be utilized, to the extent practicable.

4. Decontamination area is assumed to be an approximately 50-foot by 50-foot area, which consists of 18 inches of gravel underlain with a 40-mil high density polyethylene liner cushioned on both sides by a 12-ounce non-woven geotextile. Decontamination area is assumed to be sloped to a sump for collection of decontamination fluids.

5. Temporary access road unit cost is based on an assumed 1,900 foot-long, 24 foot-wide, 6-inch-thick gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600X). Gravel unit cost ($36/cubic yard) is based on a $17 per ton gravel cost (delivered), a 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard), and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600X) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

6. Clearing and grubbing unit cost is based on cutting and chipping of medium trees 12 to 18 inches in diameter and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system. Total clearing and grubbing area was estimated from aerial photos.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL. The estimated cost to drive, extract, and salvage the steel sheeting is estimated to be approximately $20 per square foot, based on RS Means. An additional $20,000 is included to account for the estimated total cost of installing an access road to facilitate sheeting installation with a crane.

8. Cost includes an assumed cost of $15,000 to upgrade the capacity of the existing water treatment system and a monthly maintenance cost of $5,000 to account for additional maintenance needs associated with construction activities.

9. Utility protection/relocation cost includes the estimated cost to relocate up to 7 electrical poles ($10,000/pole) around the removal and consolidation areas. In addition, the cost includes approximately $30,000 for the estimated expenses associated with relocation/replacement of miscellaneous onsite utilities (e.g., electrical line to the onsite water treatment facility, existing piping).

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<u>Table 5-5 - Cost Estimate for Remedial Alternative 4A</u>

10. Temporary stormwater management and erosion and sedimentation controls include temporary sediment controls (e.g., silt fence, haybales, filter socks, and stone check dams), miscellaneous water management (e.g., pumping of collected water to water treatment system, temporary piping/culverts), temporary seeding, and dust controls. In addition, unit cost includes maintenance costs for an approximately 2-year duration.

11. Well abandonment includes the abandonment of existing monitoring wells, piezometers, and seep wells located within the footprint of the conceptual consolidation and stormwater basin areas.

12. Survey cost includes stake-out activities associated with excavation, consolidation, construction, and confirmation sampling activities.

13. Soil removal and consolidation quantity represents the total quantity of in-situ material requiring excavation prior to consolidation within the Former Type III Landfill, Western Disposal Area, and Monarch HRDL consolidation areas. Soil removal and consolidation cost includes excavation and loading of PCB-containing materials, onsite transport to placement area within the consolidation areas, and placement and compaction in 12-inch lifts within the consolidation areas. Estimated quantities are based on removal and consolidation of approximately 190,000 cubic yards of material along the peripheral areas of the Former Type III Landfill and the Western Disposal Area (including the Panelyte Property, Panelyte Marsh, and Conrail Property), and approximately 35,000 cubic yards of material along the peripheral area of the Monarch HRDL.

14. Soil removal and processing/loading into disposal containers quantity represents the total quantity of in-situ material requiring excavation prior to offsite transportation and disposal. Soil removal cost includes excavation and loading of PCB-containing materials, as well as soil stabilization. Means of soil stabilization are unknown and may include temporary staging to allow for gravity dewatering, onsite soil mixing, and/or augmentation with a stabilizing agent (e.g., cement kiln dust or fly ash). Estimated quantities are based on removal and offsite disposal of approximately 40,500 cubic yards of PCB-containing soil from the Commercial Properties (Goodwill Lawn Area and Consumers Power only) and Residential/MHLLC Properties (including Golden Age).

15. Confirmation sample quantity assumes that removal areas, located outside of the conceptual consolidation area (approximately 11 acres or 480,000 square feet), will be sampled on a 50 foot by 50 foot grid to confirm removal of PCB-containing material. Sampling costs are assumed to be the same as the costs for analyses (i.e., $180/sample for analysis; therefore, $180 x 2 = $360 for sampling and analysis).

16. Offsite transportation and disposal cost for Non-TSCA material is based on the assumption that all of the excavated soils associated with the Commercial (Goodwill Lawn Area and Consumers Power only) and Residential/MHLLC Properties (including Golden Age), will require segregation and offsite disposal as Non-TSCA. Unit cost is based on a disposal rate of $15/ton and a transportation rate of $15/ton. In-place material density is assumed to be approximately 120 pounds per cubic foot (1.6 tons/cubic yard).

17. Grade verification survey cost estimate includes two surveys of the consolidation/cover system areas. The first survey would be performed prior to commencing filling activities. The second survey would be performed immediately prior to the installation of the liner system (i.e., liner subgrade survey). Each survey is assumed to take approximately four weeks.

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Table 5-5 - Cost Estimate for Remedial Alternative 4A

18. Soil grading layer cost estimate is based on an assumed 6-inch-thick layer of select fill covering the entire cover system areas and is the first layer of the impermeable final cover system. Select fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL

19. Geotextile separation layer cost estimate assumes utilizing a non-woven geotextile covering the entire cover system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on information provided by geotextile manufacturer. Estimated quantities are subdivided as follows:

    - 58,100 square yards: Former Type III Landfill
    - 69,700 square yards: Western Disposal Area
    - 34,800 square yards: Monarch HRDL

20. Estimated cost for gas venting layer is based on the assumption that a 12-inch sand layer will be placed on top of the geotextile separation layer of the Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas only, as these areas will consist of an impermeable cover system.

21. Estimated cost for passive gas vent installation is based on an installation frequency of 1.2 vents/acre within the Former Type III Landfill, the Western Disposal Area, and the Monarch HRDL areas only, as these areas will consist of an impermeable cover system.

22. Estimated cost for 30-mil PVC liner is based on the assumption that an impermeable liner will be placed over the 12-inch sand layer of the Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas only, as these areas will consist of an impermeable cover system.

23. Estimated cost for installation of geotextile cushion layer (16 oz) is based on the assumption that a geotextile layer will be placed over the 30-mil PVC liner in the Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas only, as these areas will consist of an impermeable cover system. The estimated quantity includes an additional 20% material quantity to account for overlap and wrinkles.

24. Soil protection/drainage layer consists of a 2-foot-thick layer of sand covering the entire cover system area. Sand fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 32,400 cubic yards: Former Type III Landfill
    - 38,800 cubic yards: Western Disposal Area
    - 19,200 cubic yards: Monarch HRDL

Table 5-5 - Cost Estimate for Remedial Alternative 4A

25. Topsoil layer consists of a 6-inch-thick layer of topsoil covering the entire cover system areas. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement. Estimated quantities are subdivided as follows:

    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL

26. Seed and mulch cost estimate is based on seeding and mulching the entire area subject to consolidation/final cover system. The per acre unit cost is derived based on an estimated cost of $3,500/acre, which was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

27. Total length of the vegetated swale is based on a conceptual cover system layout prepared for cost estimating purposes only, and includes both perimeter swales/ditches and mid-slope swales. In addition, it is assumed that the linear foot unit cost to construct a perimeter swale is equal to the cost to construct a mid-slope swale. Vegetated swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and 2-foot-deep channel geometry. Vegetated swale unit cost includes the cost to excavate the swale ($2/cubic yard), install a 6-inch topsoil layer ($30/cubic yard), and cover with erosion control matting ($0.75/square yard).

28. Total length of the riprap-lined swale is based on a conceptual cover system layout prepared for cost estimating purposes only. Riprap-lined swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and a 2-foot-deep channel geometry. Channel lining is assumed to consist of a 15-inch-thick layer of riprap underlain with a non-woven geotextile. Riprap-lined swale unit cost includes the cost to excavate the swale ($2/cubic yard), install the non-woven geotextile ($2.25/square yard), and install riprap ($100/cubic yard).

29. Riprap slope protection quantity is based on an assumed 40-foot-wide, 1,200-foot-long, by 15-inch-thick layer of riprap installed along the southeast bank of Portage Creek to protect the toe of the cover system side slope. Riprap material and placement cost is approximately $100 per cubic yard. Non-woven geotextile (i.e., Mirafi S800) unit cost ($2.25/square yard) is based on information provided by the manufacturer.

30. Total length of culvert piping is based on a conceptual cover system layout prepared for cost estimating purposes only. Unit cost ($20/linear foot) is based on an assumed 18-inch diameter high density polyethylene (HDPE) pipe, Type S, and includes material and installation costs. Unit cost was obtained from RS Means.

31 It is anticipated that subsurface drainage would be installed at the interface between the consolidation area and the existing Bryant HRDLs and FRDLs liner system. Liner system grades at the interface are assumed to slope downward on a 4 on 1 slope forming a v-notch channel containing the subsurface drainage piping. Subsurface drainage is assumed to consist of a 6-inch diameter perforated pipe ($8.45 /linear foot) and a 6-inch-thick layer of drainage stone mounded over top the pipe ($61.50/cubic yard). In addition, the perforated pipe and drainage stone are wrapped in a non-woven geotextile ($2.25/square yard). Pipe and drainage stone unit costs were obtained from RS Means, and include material and installation costs. Additional geotextile material is assumed for a full-width overlap of each side of the geotextile in the longitudinal direction.

32. Stormwater basin unit cost represents an average per basin cost, which was developed from a conceptual stormwater basin configuration. Stormwater basin unit cost includes construction of an embankment (where applicable), topsoiling and seeding of the entire basin area, and construction of a corrugated metal pipe riser outlet structure. It is preliminarily assumed that a stormwater basin will be required for each of the Former Type III landfill, Western Disposal Area, and Monarch HRDL consolidation/cover system areas.

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Table 5-5 - Cost Estimate for Remedial Alternative 4A

33. As-built survey consists of a detailed topographic and feature survey of the disturbed area. As-built survey cost includes both field and office support costs.

34. Estimated cost for backfill is partially based on calculation, as it provides for an estimate of the volume of clean fill material that will be required to backfill the peripheral soil removal areas associated with the Former Type III Landfill, Western Disposal Area, and Monarch HRDL to appropriate subgrade elevation. Actual volume to be determined during design phase. The estimated cost for backfill also assumes that the voids created by removal of PCB-containing soil from certain outlying areas (i.e., Golden Age, Residential Properties, MHLLC-Owned Property, Goodwill Lawn Area, and Consumers Power) will be replaced with clean backfill to within 6 inches of pre-existing grades (allowing for subsequent topsoil placement).

35. Topsoil quantity is based on covering approximately 11 acres of soil removal area, located outside the limits of capping, with 6 inches of topsoil. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement.

36. Seed and mulch quantity is based on covering the 11 acres of topsoil placed over the outlying soil removal areas, as necessary to promote vegetative growth. Unit cost (i.e., $3,500/acre) was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

37. Permanent access road quantity based on an assumed 7,600 linear feet of newly constructed road that will be required to access various portions of the cover system area for maintenance purposes. Permanent access roads are assumed to consist of a 24 foot-wide, 1-foot-thick, gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600x). Access road unit cost was based on a gravel material cost of $17 per ton (delivered), an assumed 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard) and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600x) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

38. The estimated cost for installation of permanent gas probes is based on the assumption that a series of six permanent gas monitoring probes will be installed along perimeters of the Former Type III Landfill, the Western Disposal Area, and the Monarch HRDL to monitor landfill gas concentrations at locations adjacent to neighboring properties.

39. The estimated cost for installation of permanent gas probes is based on the assumption that a series of six permanent gas monitoring probes will be installed along perimeters of the Western Disposal Area and the Monarch HRDL to monitor landfill gas concentrations at locations adjacent to neighboring properties.

40. The estimated cost for installation of perimeter gas venting trenches is based on the assumption that 5-foot deep, 2-foot wide gas venting trenches, consisting of trenches filled with crushed stone/pea gravel and perforated piping affixed with wind turbine ventilators, will be installed along the perimeters of the Western Disposal Area and the Monarch HRDL to vent landfill gas from the subsurface before encroaching onto adjacent neighboring properties.

41. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a quarterly basis for the first 5 years of the post-closure period.

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Table 5-5 - Cost Estimate for Remedial Alternative 4A

42. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the net present value (NPV) or present worth, and is based on an annual cost of approximately $25,000 at a 7% discount rate.

43. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a quarterly basis for the first 5 years of the post-closure period.

44. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $2,000 at a 7% discount rate.

45. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a quarterly basis for the first 5 years of the post-closure period, and will include PCB and a variety of non-PCB constituents.

46. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period, and will include PCB and a variety of non-PCB constituents. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $125,000 at a 7% discount rate.

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Table 5-6 - Cost Estimate for Remedial Alternative 4B

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1.	Pre-Construction Field Survey	1	LS	$60,000	$60,000
2.	Air Monitoring Program	280	DAY	$1,200	$336,000
3.	Temporary Fencing	1	LS	$10,000	$10,000
4.	Decontamination Area	1	EA	$35,000	$35,000
5.	Temporary Construction Access Roads	1	LS	$100,000	$100,000
6.	Clearing & Grubbing	20	AC	$9,000	$180,000
7.	Temporary Steel Sheeting	1	LS	$2,160,000	$2,160,000
8.	Upgrade of Existing Water Treatment System and Monthly Maintenance Associated with Construction	1	LS	$95,000	$95,000
9.	Utility Protection / Relocation	1	LS	$100,000	$100,000
10.	Temporary Stormwater Management and Erosion and Sediment	1	LS	$420,000	$420,000
11.	Well Abandonment	18	EA	$500	$9,000
				Site Preparation Subtotal:	**$3,505,000**
Excavation and Consolidation					
12.	Survey	10	WK	$8,600	$86,000
13.	Soil Removal & Consolidation	225,000	CY	$10	$2,250,000
14.	Soil Removal & Processing/Loading into Disposal Containers	91,000	CY	$8	$728,000
15.	Confirmation Sampling	244	EA	$360	$87,840
				Excavation and Consolidation Subtotal:	**$3,151,840**
Offsite Transportation & Disposal					
16.	Offsite Transportation & Disposal - Non-TSCA	145,600	TN	$30	$4,368,000
				Offsite Transportation & Disposal Subtotal:	**$4,368,000**
Final Cover System					
17.	Grade Verification Surveys	8	WK	$8,600	$68,800
18.	Soil Grading Layer (Select Fill)	22,600	CY	$20	$452,000
19.	Geotextile Separation Layer (8-oz/sy)	162,600	SY	$2.25	$365,850
20.	Gas Venting Layer (Sand)	45,300	CY	$20	$906,000
21.	Passive Gas Vents	34	EA	$750	$25,200
22.	30-mil PVC Liner	135,500	SY	$6.40	$867,200
23.	Geotextile Cushion Layer (16-oz/sy)	162,600	SY	$4.25	$691,050
24.	Soil Protection / Drainage Layer (Sand)	90,400	CY	$20	$1,808,000
25.	Topsoil Layer	22,600	CY	$30	$678,000
26.	Seed & Mulch	28	AC	$3,500	$98,000
				Final Cover System Subtotal:	**$5,960,100**
Permanent Storm Water Management					
27.	Vegetated Swales	9,200	LF	$15	$138,000
28.	Riprap-Lined Swales	3,750	LF	$100	$375,000
29.	Riprap Slope Protection	1	LS	$370,000	$370,000
30.	Culverts	900	LF	$20	$18,000
31.	Subsurface Drain Piping	3,900	LF	$45	$175,500
32.	Stormwater Basins	3	EA	$60,000	$180,000
				Permanent Storm Water Management Subtotal:	**$1,256,500**
Restoration					
33.	As-Built Survey	6	WK	$8,600	$51,600
34.	Backfill	137,000	CY	$20	$2,740,000
35.	Topsoil	11,300	CY	$30	$339,000
36.	Seed & Mulch	14	AC	$3,500	$49,000
37.	Permanent Gravel Access Roads	1	LS	$275,000	$275,000
				Restoration Subtotal:	**$3,454,600**
Post-Closure Monitoring Features Installation					
38.	Installation of Permanent Gas Monitoring Probes	6	EA	$5,000	$30,000
39.	Installation of Perimeter Gas Venting Trenches	19,250	SF	$35	$673,750
40.	Installation of Post-Closure Groundwater Monitoring Well Network	20	EA	$5,000	$100,000
				Post-Closure Monitoring Features Installation Subtotal:	**$803,750**
				CAPITAL COST SUBTOTAL:	**$22,499,790**
				Mobilization/Demobilization (5% of Subtotal Capital Cost):	**$1,124,990**
				Administration, Engineering, and Construction Oversight (10% of Subtotal Capital Cost):	**$2,249,979**
				Independent Construction Quality Assurance (15% of Final Cover System Capital Costs):	**$894,015**
				Contingency (20% of Subtotal Capital Cost):	**$4,499,958**
				TOTAL CAPITAL COST:	**$31,268,732**

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Table 5-6 - Cost Estimate for Remedial Alternative 4B

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
II. OPERATION AND MAINTENANCE (O&M) COSTS					
Post-Closure Inspections & Maintenance					
41.	Years 1-5	5	YR	$100,000	$500,000
42.	Years 6-30	1	LS	$290,000	$290,000
				Post-Closure Inspections & Maintenance Subtotal:	**$790,000**
Post-Closure Landfill Gas Monitoring & Reporting					
43.	Years 1-5	5	YR	$4,000	$20,000
44.	Years 6-30	1	LS	$24,000	$24,000
				Post-Closure Landfill Gas Monitoring & Reporting Subtotal:	**$44,000**
Post-Closure Groundwater Sampling & Reporting					
45.	Years 1-5	5	YR	$250,000	$1,250,000
46.	Years 6-30	1	LS	$1,500,000	$1,500,000
				Post-Closure Groundwater Sampling & Reporting:	**$2,750,000**
				O&M COST SUBTOTAL:	**$3,584,000**
				Contingency (20% of Subtotal O&M Cost):	**$716,800**
				TOTAL O&M COST:	**$4,300,800**
				TOTAL ESTIMATED COST:	**$35,569,532**
				ROUNDED TO:	**$35,600,000**

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Table 5-6 - Cost Estimate for Remedial Alternative 4B - Notes & Assumptions

General Notes:

A. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

B. Unit prices are based on 2009 dollars.

C. All volumes represent in-place measures.

D. Where not otherwise noted, unit cost is based on past project experience.

E. The total conceptual consolidation/cover system area is approximately 28 acres, subdivided as follows:

- 10 acres: Former Type III Landfill
- 12 acres: Western Disposal Area
- 6 acres: Monarch HRDL

F. The total area of PCB-containing soil (i.e., consolidation/cover system area as well as peripheral and outlying soil removal areas) is approximately 42 acres, subdivided as follows:

- 13.6 acres: Former Type III Landfill
- 15.6 acres: Western Disposal Area (including Panelyte Property, Panelyte Marsh, and Conrail Property)
- 6.8 acres: Monarch HRDL
- 4.8 acres: Commercial Properties (i.e., Goodwill Parking Lots, Goodwill Lawn Area, Consumers Power, and Alcott Street Parking Lot)
- 1.5 acres: Residential/MHLLC-Owned Properties (including Golden Age)

G. Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

H. "RS Means" refers to RS Means Heavy Construction Cost Data 2009.

I. "Aerial Photos" refers to images obtained from Microsoft® Live Search website (http://maps.live.com).

J. CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton WK=Week; MO=Month.

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Table 5-6 - Cost Estimate for Remedial Alternative 4B - Notes & Assumptions

Item Notes:

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking OU features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during PCB-containing material handling only (e.g., excavation, consolidation, subgrade preparation), the duration of which is assumed to be approximately 14 months total. It is also assumed that 3 PCB PolyUrethane Foam (PUF) samples will be collected per day (i.e., one-sample up-wind and two down-wind samples). Air monitoring unit cost includes the preliminary estimated cost of the rental equipment ($260/day), analysis ($600 for 3 samples), shipping ($40/day), and labor ($300/day).

3. Temporary fence quantity represents the additional fencing needed to completely enclose and secure the various work areas. It is assumed that existing fence will be utilized, to the extent practicable.

4. Decontamination area is assumed to be an approximately 50-foot by 50-foot area, which consists of 18 inches of gravel underlain with a 40-mil high density polyethylene liner cushioned on both sides by a 12-ounce non-woven geotextile. Decontamination area is assumed to be sloped to a sump for collection of decontamination fluids.

5. Temporary access road unit cost is based on an assumed 1,900 foot-long, 24 foot-wide, 6-inch-thick gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600X). Gravel unit cost ($36/cubic yard) is based on a $17 per ton gravel cost (delivered), a 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard), and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600X) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

6. Clearing and grubbing unit cost is based on cutting and chipping of medium trees 12 to 18 inches in diameter and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system. Total clearing and grubbing area was estimated from aerial photos.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL. The estimated cost to drive, extract, and salvage the steel sheeting is estimated to be approximately $20 per square foot, based on RS Means. An additional $20,000 is included to account for the estimated total cost of installing an access road to facilitate sheeting installation with a crane. This line item also includes approximately $1,750,000 of temporary steel sheeting to facilitate soil removal activities within the Goodwill and Alcott Street Parking Lot areas. Given the anticipated depth of excavation in this area (i.e., 20 feet below ground surface) combined with the proximity of the building adjacent to the Goodwill Parking Lots, sheeting will likely be required. Special methods will also be required to drive the sheets while minimizing the potential for damage to the adjacent structure (e.g., trenching and pre-drilling, pile driving using low vibratory methods, crack, vibration, and settlement monitoring). Estimated cost is based on approximately 35,000 square feet of sheeting at $50 per square foot to procure, install, and extract the sheet piles.

8. Cost includes an assumed cost of $15,000 to upgrade the capacity of the existing water treatment system and a monthly maintenance cost of $5,000 to account for additional maintenance needs associated with construction activities.

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Table 5-6 - Cost Estimate for Remedial Alternative 4B - Notes & Assumptions

9. Utility protection/relocation cost includes the estimated cost to relocate up to 7 electrical poles ($10,000/pole) around the removal and consolidation areas. In addition, the cost includes approximately $30,000 for the estimated expenses associated with relocation/replacement of miscellaneous onsite utilities (e.g., electrical line to the onsite water treatment facility, existing piping).

10. Temporary stormwater management and erosion and sedimentation controls include temporary sediment controls (e.g., silt fence, haybales, filter socks, and stone check dams), miscellaneous water management (e.g., pumping of collected water to water treatment system, temporary piping/culverts), temporary seeding, and dust controls. In addition, unit cost includes maintenance costs for an approximately 2-year duration.

11. Well abandonment includes the abandonment of existing monitoring wells, piezometers, and seep wells located within the footprint of the conceptual consolidation and stormwater basin areas.

12. Survey cost includes stake-out activities associated with excavation, consolidation, construction, and confirmation sampling activities.

13. Soil removal and consolidation quantity represents the total quantity of in-situ material requiring excavation prior to consolidation within the Former Type III Landfill, Western Disposal Area, and Monarch HRDL consolidation areas. Soil removal and consolidation cost includes excavation and loading of PCB-containing materials, onsite transport to placement area within the consolidation areas, and placement and compaction in 12-inch lifts within the consolidation areas. Estimated quantities are based on removal and consolidation of approximately 190,000 cubic yards of material along the peripheral areas of the Former Type III Landfill and the Western Disposal Area (including the Panelyte Property, Panelyte Marsh, and Conrail Property), and approximately 35,000 cubic yards of material along the peripheral area of the Monarch HRDL.

14. Soil removal and processing/loading into disposal containers quantity represents the total quantity of in-situ material requiring excavation prior to off-site transportation and disposal. Soil removal cost includes excavation and loading of PCB-containing materials, as well as soil stabilization. Means of soil stabilization are unknown and may include temporary staging to allow for gravity dewatering, onsite soil mixing, and/or augmentation with a stabilizing agent (e.g., cement kiln dust or fly ash). Estimated quantities are based on removal and offsite disposal of approximately 91,000 cubic yards of PCB-containing soil from the Commercial Properties (Goodwill Lawn Area, Goodwill Parking Lots, Consumers Power only, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age).

15. Confirmation sample quantity assumes that removal areas, located outside of the conceptual consolidation area (approximately 14 acres or 610,000 square feet), will be sampled on a 50 foot by 50 foot grid to confirm removal of PCB-containing material. Sampling costs are assumed to be the same as the costs for analyses (i.e., $180/sample for analysis; therefore, $180 x 2 = $360 for sampling and analysis).

16. Offsite transportation and disposal cost for Non-TSCA material is based on the assumption that all of the excavated soils associated with the Commercial (Goodwill Lawn Area, Goodwill Parking Lot, Consumers Power, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age), will require segregation and offsite disposal as Non-TSCA. Unit cost is based on a disposal rate of $15/ton and a transportation rate of $15/ton. In-place material density is assumed to be approximately 120 pounds per cubic foot (1.6 tons/cubic yard).

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Table 5-6 - Cost Estimate for Remedial Alternative 4B - Notes & Assumptions

17. Grade verification survey cost estimate includes two surveys of the consolidation/cover system areas. The first survey would be performed prior to commencing filling activities. The second survey would be performed immediately prior to the installation of the liner system (i.e., liner subgrade survey). Each survey is assumed to take approximately four weeks.

18. Soil grading layer cost estimate is based on an assumed 6-inch-thick layer of select fill covering the entire cover system areas and is the first layer of the permeable final cover system. Select fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL

19. Geotextile separation layer cost estimate assumes utilizing a non-woven geotextile covering the entire cover system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on information provided by geotextile manufacturer. Estimated quantities are subdivided as follows:

    - 58,100 square yards: Former Type III Landfill
    - 69,700 square yards: Western Disposal Area
    - 34,800 square yards: Monarch HRDL

20. Estimated cost for gas venting layer is based on the assumption that a 12-inch sand layer will be placed on top of the geotextile separation layer of the Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas only, as these areas will consist of an impermeable cover system.

21. Estimated cost for passive gas vent installation is based on an installation frequency of 1.2 vents/acre within the Former Type III Landfill, the Western Disposal Area, and the Monarch HRDL areas only, as these areas will consist of an impermeable cover system.

22. Estimated cost for 30-mil PVC liner is based on the assumption that an impermeable liner will be placed over the 12-inch sand layer of the Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas only, as these areas will consist of an impermeable cover system.

23. Estimated cost for installation of geotextile cushion layer (16 oz) is based on the assumption that a geotextile layer will be placed over the 30-mil PVC liner in the Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas only, as these areas will consist of an impermeable cover system. The estimated quantity includes an additional 20% material quantity to account for overlap and wrinkles.

24. Soil protection/drainage layer consists of a 2-foot-thick layer of sand covering the entire cover system area. Sand fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 32,400 cubic yards: Former Type III Landfill
    - 38,800 cubic yards: Western Disposal Area
    - 19,200 cubic yards: Monarch HRDL

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Table 5-6 - Cost Estimate for Remedial Alternative 4B - Notes & Assumptions

25. Topsoil layer consists of a 6-inch-thick layer of topsoil covering the entire cover system areas. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement. Estimated quantities are subdivided as follows:

    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL

26. Seed and mulch cost estimate is based on seeding and mulching the entire area subject to consolidation/final cover system. The per acre unit cost is derived based on an estimated cost of $3,500/acre, which was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

27. Total length of the vegetated swale is based on a conceptual cover system layout prepared for cost estimating purposes only, and includes both perimeter swales/ditches and mid-slope swales. In addition, it is assumed that the linear foot unit cost to construct a perimeter swale is equal to the cost to construct a mid-slope swale. Vegetated swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and 2-foot-deep channel geometry. Vegetated swale unit cost includes the cost to excavate the swale ($2/cubic yard), install a 6-inch topsoil layer ($30/cubic yard), and cover with erosion control matting ($0.75/square yard).

28. Total length of the riprap-lined swale is based on a conceptual cover system layout prepared for cost estimating purposes only. Riprap-lined swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and a 2-foot-deep channel geometry. Channel lining is assumed to consist of a 15-inch-thick layer of riprap underlain with a non-woven geotextile. Riprap-lined swale unit cost includes the cost to excavate the swale ($2/cubic yard), install the non-woven geotextile ($2.25/square yard), and install riprap ($100/cubic yard).

29. Riprap slope protection quantity is based on an assumed 40-foot-wide, 1,200-foot-long, by 15-inch-thick layer of riprap installed along the southeast bank of Portage Creek to protect the toe of the cover system side slope. Riprap material and placement cost is approximately $100 per cubic yard. Non-woven geotextile (i.e., Mirafi S800) unit cost ($2.25/square yard) is based on information provided by the manufacturer.

30. Total length of culvert piping is based on a conceptual cover system layout prepared for cost estimating purposes only. Unit cost ($20/linear foot) is based on an assumed 18-inch diameter high density polyethylene (HDPE) pipe, Type S, and includes material and installation costs. Unit cost was obtained from RS Means.

31 It is anticipated that subsurface drainage would be installed at the interface between the consolidation area and the existing Bryant HRDLs and FRDLs liner system. Liner system grades at the interface are assumed to slope downward on a 4 on 1 slope forming a v-notch channel containing the subsurface drainage piping. Subsurface drainage is assumed to consist of a 6-inch diameter perforated pipe ($8.45 /linear foot) and a 6-inch-thick layer of drainage stone mounded over top the pipe ($61.50/cubic yard). In addition, the perforated pipe and drainage stone are wrapped in a non-woven geotextile ($2.25/square yard). Pipe and drainage stone unit costs were obtained from RS Means, and include material and installation costs. Additional geotextile material is assumed for a full-width overlap of each side of the geotextile in the longitudinal direction.

32. Stormwater basin unit cost represents an average per basin cost, which was developed from a conceptual stormwater basin configuration. Stormwater basin unit cost includes construction of an embankment (where applicable), topsoiling and seeding of the entire basin area, and construction of a corrugated metal pipe riser outlet structure. It is preliminarily assumed that a stormwater basin will be required for each of the Former Type III landfill, Western Disposal Area, and Monarch HRDL consolidation/cover system areas.

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Table 5-6 - Cost Estimate for Remedial Alternative 4B - Notes & Assumptions

33. As-built survey consists of a detailed topographic and feature survey of the disturbed area. As-built survey cost includes both field and office support costs.

34. Estimated cost for backfill is partially based on calculation, as it provides for an estimate of the volume of clean fill material that will be required to backfill the outlying soil removal areas associated with the Former Type III Landfill, Western Disposal Area, and Monarch HRDL to appropriate subgrade elevation. Actual volume to be determined during design phase. The estimated cost for backfill also assumes that the voids created by removal of PCB-containing soil from the Commercial (Goodwill Lawn Area, Goodwill Parking Lots, Consumers Power, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age) will be replaced with clean backfill to within 6 inches of pre-existing grades (allowing for subsequent topsoil placement).
35. Topsoil quantity is based on covering approximately 14 acres of soil removal area, located outside the limits of capping, with 6 inches of topsoil. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement.

36. Seed and mulch quantity is based on covering the 14 acres of topsoil placed over the outlying soil removal areas, as necessary to promote vegetative growth. Unit cost (i.e., $3,500/acre) was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

37. Permanent access road quantity based on an assumed 7,600 linear feet of newly constructed road that will be required to access various portions of the cover system area for maintenance purposes. Permanent access roads are assumed to consist of a 24 foot-wide, 1-foot-thick, gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600x). Access road unit cost was based on a gravel material cost of $17 per ton (delivered), an assumed 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard) and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600x) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

38. The estimated cost for installation of permanent gas probes is based on the assumption that a series of six permanent gas monitoring probes will be installed along perimeters of the Western Disposal Area and the Monarch HRDL to monitor landfill gas concentrations at locations adjacent to neighboring properties.

39. The estimated cost for installation of perimeter gas venting trenches is based on the assumption that 5-foot deep, 2-foot wide gas venting trenches, consisting of trenches filled with crushed stone/pea gravel and perforated piping affixed with wind turbine ventilators, will be installed along the perimeters of the Western Disposal Area and the Monarch HRDL to vent landfill gas from the subsurface before encroaching onto adjacent neighboring properties.

40. The estimated cost for installation of a post-closure groundwater monitoring network is based on the assumption that a series of groundwater monitoring wells will be installed along the entire perimeters of the Former Type III Landfill, the Western Disposal Area, and the Monarch HRDL for purposes of collecting post-closure groundwater samples.

41. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a quarterly basis for the first 5 years of the post-closure period.

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Table 5-6 - Cost Estimate for Remedial Alternative 4B - Notes & Assumptions

42. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the net present value (NPV) or present worth, and is based on an annual cost of approximately $25,000 at a 7% discount rate.

43. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a quarterly basis for the first 5 years of the post-closure period.

44. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $2,000 at a 7% discount rate.

45. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a quarterly basis for the first 5 years of the post-closure period, and will include PCB and a variety of non-PCB constituents.

46. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period, and will include PCB and a variety of non-PCB constituents. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $125,000 at a 7% discount rate.

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Table 5-7 - Cost Estimate for Remedial Alternative 5A

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1.	Pre-Construction Field Survey	1	LS	$60,000	$60,000
2.	Air Monitoring Program	1,300	DAY	$1,200	$1,560,000
3.	Temporary Fencing	1	LS	$10,000	$10,000
4.	Decontamination Area	1	EA	$35,000	$35,000
5.	Temporary Construction Access Roads	1	LS	$100,000	$100,000
6.	Clearing & Grubbing	20	AC	$9,000	$180,000
7.	Temporary Steel Sheeting	1	LS	$2,160,000	$2,160,000
8.	Upgrade of Existing Water Treatment System and Monthly Maintenance Associated with Construction	1	LS	$195,000	$195,000
9.	Temporary Water Treatment System	100	WK	$15,000	$1,500,000
10.	Utility Protection / Relocation	1	LS	$100,000	$100,000
11.	Temporary Stormwater Management and Erosion and Sediment	1	LS	$1,000,000	$1,000,000
12.	Well Abandonment	18	EA	$500	$9,000
				Site Preparation Subtotal:	**$6,909,000**
Excavation					
13.	Survey	60	WK	$8,600	$516,000
14.	Removal & Segregation of Clean Soil Cover from Bryant HRDL/FRDLs	90,000	CY	$3	$270,000
15.	Soil Removal & Processing/Loading into Disposal Containers	1,575,500	CY	$5	$7,877,500
16.	Torch-Cut Sheetpile Wall to 2 Feet Below Final Grade	2,600	LF	$30	$78,000
17.	Confirmation Sampling	1,132	EA	$360	$407,520
				Excavation Subtotal:	**$9,149,020**
Offsite Transportation & Disposal					
18.	Offsite Transportation & Disposal - TSCA	780,000	TN	$120	$93,600,000
19.	Offsite Transportation & Disposal - Non-TSCA	1,740,000	TN	$30	$52,200,000
				Offsite Transportation & Disposal Subtotal:	**$145,800,000**
Restoration					
20.	As-Built Survey	6	WK	$8,600	$51,600
21.	Backfill	138,600	CY	$20	$2,772,000
22.	Topsoil	52,400	CY	$30	$1,572,000
23.	Seed & Mulch	65	AC	$3,500	$227,500
				Restoration Subtotal:	**$4,623,100**
				CAPITAL COST SUBTOTAL:	**$166,481,120**
				Mobilization/Demobilization (5% of Subtotal Capital Cost):	**$8,324,056**
				Administration, Engineering, and Construction Oversight ($900,000/Year of Remedial Action):	**$4,500,000**
				Contingency (20% of Subtotal Capital Cost):	**$33,296,224**
				TOTAL ESTIMATED COST:	**$212,601,400**
				ROUNDED TO:	**$212,600,000**

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Table 5-7 - Cost Estimate for Remedial Alternative 5A

General Notes:

A. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

B. Unit prices are based on 2009 dollars.

C. All volumes represent in-place measures.

D. Where not otherwise noted, unit cost is based on past project experience.

E. The total area of PCB-containing soil is approximately 65 acres, subdivided as follows:

- 22.1 acres: Bryant HRDL/FRDLs
- 13.6 acres: Former Type III Landfill
- 15.6 acres: Western Disposal Area (including Panelyte Property, Panelyte Marsh, and Conrail Property)
- 6.8 acres: Monarch HRDL
- 4.8 acres: Commercial Properties (i.e., Goodwill Parking Lots, Goodwill Lawn Area, Consumers Power, and Alcott Street Parking Lot)
- 1.5 acres: Residential/MHLLC-Owned Properties (including Golden Age)

F. Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

G. "RS Means" refers to RS Means Heavy Construction Cost Data 2009.

H. "Aerial Photos" refers to images obtained from Microsoft® Live Search website (http://maps.live.com).

I. CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton WK=Week; MO=Month.

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Table 5-7 - Cost Estimate for Remedial Alternative 5A

Item Notes:

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking OU features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during PCB-containing material handling only (e.g., excavation, consolidation, subgrade preparation), the duration of which is assumed to be approximately 5 years total. It is also assumed that 3 PCB PolyUrethane Foam (PUF) samples will be collected per day (i.e., one-sample up-wind and two down-wind samples). Air monitoring unit cost includes the preliminary estimated cost of the rental equipment ($260/day), analysis ($600 for 3 samples), shipping ($40/day), and labor ($300/day).
3. Temporary fence quantity represents the additional fencing needed to completely enclose and secure the various work areas. It is assumed that existing fence will be utilized, to the extent practicable.

4. Decontamination area is assumed to be an approximately 50-foot by 50-foot area, which consists of 18 inches of gravel underlain with a 40-mil high density polyethylene liner cushioned on both sides by a 12-ounce non-woven geotextile. Decontamination area is assumed to be sloped to a sump for collection of decontamination fluids.

5. Temporary access road unit cost is based on an assumed 1,900 foot-long, 24 foot-wide, 6-inch-thick gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600X). Gravel unit cost ($36/cubic yard) is based on a $17 per ton gravel cost (delivered), a 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard), and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600X) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

6. Clearing and grubbing unit cost is based on cutting and chipping of medium trees 12 to 18 inches in diameter and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system. Total clearing and grubbing area was estimated from aerial photos.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL. The estimated cost to drive, extract, and salvage the steel sheeting is estimated to be approximately $20 per square foot, based on RS Means. An additional $20,000 is included to account for the estimated total cost of installing an access road to facilitate sheeting installation with a crane. This line item also includes approximately $1,750,000 of temporary steel sheeting to facilitate soil removal activities within the Goodwill and Alcott Street Parking Lot areas. Given the anticipated depth of excavation in this area (i.e., 20 feet below ground surface) combined with the proximity of the building adjacent to the Goodwill Parking Lots, sheeting will likely be required. Special methods will also be required to drive the sheets while minimizing the potential for damage to the adjacent structure (e.g., trenching and pre-drilling, pile driving using low vibratory methods, crack, vibration, and settlement monitoring). Estimated cost is based on approximately 35,000 square feet of sheeting at $50 per square foot to procure, install, and extract the sheet piles.

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Table 5-7 - Cost Estimate for Remedial Alternative 5A

8. Cost includes an assumed cost of $15,000 to upgrade the capacity of the existing water treatment system and a monthly maintenance cost of $5,000 to account for additional maintenance needs associated with construction activities for the first 3 years of construction. After the first 3 years, it is assumed that the existing onsite water treatment system will be decommissioned as it is located within the soil removal area. For the remaining 2 years of construction, it is assumed that a temporary onsite water treatment system will be utilized (see Item 9 below).

9. Estimated cost for temporary onsite water treatment system is based on the assumption that the existing onsite water treatment system will no longer be available for use following the first 3 years of construction. Estimated cost is based on one mobilization/demobilization.

10. Utility protection/relocation cost includes the estimated cost to relocate up to 7 electrical poles ($10,000/pole) around the removal and consolidation areas. In addition, the cost includes approximately $30,000 for the estimated expenses associated with relocation/replacement of miscellaneous on-site utilities (e.g., electrical line to the onsite water treatment facility, existing piping).

11. Temporary stormwater management and erosion and sedimentation controls include temporary sediment controls (e.g., silt fence, haybales, filter socks, and stone check dams), miscellaneous water management (e.g., pumping of collected water to water treatment system, temporary piping/culverts), temporary seeding, and dust controls. In addition, unit cost includes maintenance costs for an approximately 2-year duration.

12. Well abandonment includes the abandonment of existing monitoring wells, piezometers, and seep wells located within the footprint of the conceptual excavation and stormwater basin areas.

13. Survey cost includes stake-out activities associated with excavation, construction, and confirmation sampling activities.

14. Cost for removal and segregation of clean soil cover materials is based on the assumption that approximately 90,000 cubic yards of clean soil cover currently exists on top of the Bryant HRDL/FRDLs, and would be removed and segregated for subsequent use as backfill.

15. Soil removal and processing/loading into disposal containers quantity represents the total quantity of in-situ material requiring excavation prior to off-site transportation and disposal. Soil removal cost includes excavation and loading of PCB-containing materials, as well as soil processing/handling. Means of soil stabilization are unknown and may include temporary staging to allow for gravity dewatering, onsite soil mixing, and/or augmentation with a stabilizing agent (e.g., cement kiln dust or fly ash). Such processing/handling is only intended to remove free liquids in order to pass USEPA paint filter test prior to offsite transportation and disposal. Estimated quantities are as follows:

    - 635,000 cubic yards: Bryant HRDL/FRDLs
    - 170,100 cubic yards: Monarch HRDL (including Former Raceway Channel)
    - 405,000 cubic yards: Former Type III Landfill
    - 274,400 cubic yards: Western Disposal Area (including Panelyte Property, Panelyte Marsh, and Conrail Property)
    - 80,100 cubic yards: Commercial Properties (including Goodwill Lawn Area, Goodwill Parking Lots, Consumers Power, and Alcott Street Parking Lot)
    - 10,900 cubic yards: Residential/MHLLC Properties (including Golden Age)

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Table 5-7 - Cost Estimate for Remedial Alternative 5A

16. Estimated cost to torch-cut sheetpile wall assumes that the existing sheetpile wall along the Bryant HRDL/FRDLs will be cut to at least 2 feet below final grade (final grade to be determined during design phase). Estimated cost includes approximately $7.00 per linear foot to excavate soils along the sheetpile wall to allow access for cutting, $5.00 per linear foot to cut the steel sheetpile, and approximately $18.00 per linear foot to operate and maintain a crane onsite to handle and stage the removed sheetpiles (unit cost derived from assumed 15 days of cutting at approximately $3,000 per day for a crane). No costs for offsite transportation and disposal are includes as it is assumed that such costs will be offset by the salvage/re-sale value of the removed sheetpiles.
17. Confirmation sample quantity assumes that all soil removal areas (approximately 65 acres or 2,830,000 square feet), will be sampled on a 50 foot by 50 foot grid to confirm removal of PCB-containing material. Sampling costs are assumed to be the same as the costs for analyses (i.e., $180/sample for analysis; therefore, $180 x 2 = $360 for sampling and analysis).
18. Offsite transportation and disposal cost for TSCA material is based on the assumption that approximately 33% of the soil removed from the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL will require offsite transportation and disposal as TSCA material, and all remaining soils will be managed as non-TSCA (see Note 19 below). Unit cost is based on a disposal rate of $85/ton and a transportation rate of $35/ton. In-place material density is assumed to be approximately 120 pounds per cubic foot (1.6 tons/cubic yard).
19. Offsite transportation and disposal cost for Non-TSCA material is based on the assumption that approximately 66% of the soil removed from the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL will require offsite transportation and disposal as Non-TSCA material, and all of the excavated soils associated with the Commercial (Goodwill Lawn Area, Goodwill Parking Lot, Consumers Power, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age), will also require segregation and offsite disposal as Non-TSCA. Unit cost is based on a disposal rate of $15/ton and a transportation rate of $15/ton. In-place material density is assumed to be approximately 120 pounds per cubic foot (1.6 tons/cubic yard).
20. As-built survey consists of a detailed topographic and feature survey of the disturbed area. As-built survey cost includes both field and office support costs.
21. Estimated cost for backfill is partially based on calculation, as it provides for an estimate of the volume of clean fill material that will be required to backfill the soil removal areas associated with the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL to appropriate subgrade elevation. Actual volume to be determined during design phase. The estimated cost for backfill also assumes that the voids created by removal of PCB-containing soil from the Commercial (Goodwill Lawn Area, Goodwill Parking Lots, Consumers Power, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age) will be replaced with clean backfill to within 6 inches of pre-existing grades (allowing for subsequent topsoil placement).
22. Topsoil quantity is based on covering approximately 65 acres of soil removal area with 6 inches of topsoil. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement.
23. Seed and mulch quantity is based on covering the 65 acres of topsoil placed over the soil removal areas, as necessary to promote vegetative growth. Unit cost (i.e., $3,500/acre) was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

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Table 5-8 - Cost Estimate for Remedial Alternative 5B

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1.	Pre-Construction Field Survey	1	LS	$60,000	$60,000
2.	Air Monitoring Program	1,400	DAY	$1,200	$1,680,000
3.	Temporary Fencing	1	LS	$10,000	$10,000
4.	Decontamination Area	1	EA	$35,000	$35,000
5.	Temporary Construction Access Roads	1	LS	$100,000	$100,000
6.	Clearing & Grubbing	20	AC	$9,000	$180,000
7.	Temporary Steel Sheeting	1	LS	$2,160,000	$2,160,000
8.	Upgrade of Existing Water Treatment System and Monthly Maintenance Associated with Construction	1	LS	$195,000	$195,000
9.	Temporary Water Treatment System	120	WK	$15,000	$1,800,000
10.	Utility Protection / Relocation	1	LS	$100,000	$100,000
11.	Temporary Stormwater Management and Erosion and Sediment	1	LS	$1,000,000	$1,000,000
12.	Well Abandonment	18	EA	$500	$9,000
				Site Preparation Subtotal:	**$7,329,000**
Excavation					
13.	Survey	60	WK	$8,600	$516,000
14.	Removal & Segregation of Clean Soil Cover from Bryant HRDL/FRDLs	90,000	CY	$3	$270,000
15.	Soil Removal & Processing/Loading into Disposal Containers	1,575,500	CY	$5	$7,877,500
16.	Addition of 6% Cement for Immobilization	94,530	CY	$3	$283,590
17.	Torch-Cut Sheetpile Wall to 2 Feet Below Final Grade	2,600	LF	$30	$78,000
18.	Confirmation Sampling	1,132	EA	$360	$407,520
				Excavation Subtotal:	**$9,432,610**
Offsite Transportation & Disposal					
19.	Offsite Transportation & Disposal - TSCA	830,000	TN	$120	$99,600,000
20.	Offsite Transportation & Disposal - Non-TSCA	1,840,000	TN	$30	$55,200,000
				Offsite Transportation & Disposal Subtotal:	**$154,800,000**
Restoration					
21.	As-Built Survey	6	WK	$8,600	$51,600
22.	Backfill	138,600	CY	$20	$2,772,000
23.	Topsoil	52,400	CY	$30	$1,572,000
24.	Seed & Mulch	65	AC	$3,500	$227,500
				Restoration Subtotal:	**$4,623,100**
				CAPITAL COST SUBTOTAL:	**$176,184,710**
				Mobilization/Demobilization (5% of Subtotal Capital Cost):	**$8,809,236**
				Administration, Engineering, and Construction Oversight ($900,000/Year of Remedial Action):	**$4,500,000**
				Contingency (20% of Subtotal Capital Cost):	**$35,236,942**
				TOTAL ESTIMATED COST:	**$224,730,888**
				ROUNDED TO:	**$224,700,000**

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Table 5-8 - Cost Estimate for Remedial Alternative 5B

General Notes:

A. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

B. Unit prices are based on 2009 dollars.

C. All volumes represent in-place measures.

D. Where not otherwise noted, unit cost is based on past project experience.

E. The total area of PCB-containing soil is approximately 65 acres, subdivided as follows:

- 22.1 acres: Bryant HRDL/FRDLs
- 13.6 acres: Former Type III Landfill
- 15.6 acres: Western Disposal Area (including Panelyte Property, Panelyte Marsh, and Conrail Property)
- 6.8 acres: Monarch HRDL
- 4.8 acres: Commercial Properties (i.e., Goodwill Parking Lots, Goodwill Lawn Area, Consumers Power, and Alcott Street Parking Lot)
- 1.5 acres: Residential/MHLLC-Owned Properties (including Golden Age)

F. Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

G. "RS Means" refers to RS Means Heavy Construction Cost Data 2009.

H. "Aerial Photos" refers to images obtained from Microsoft® Live Search website (http://maps.live.com).

I. CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton WK=Week; MO=Month.

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Table 5-8 - Cost Estimate for Remedial Alternative 5B

Notes:

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking OU features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during PCB-containing material handling only (e.g., excavation, consolidation, subgrade preparation), the duration of which is assumed to be approximately 5 1/3 years total. It is also assumed that 3 PCB PolyUrethane Foam (PUF) samples will be collected per day (i.e., one-sample up-wind and two down-wind samples). Air monitoring unit cost includes the preliminary estimated cost of the rental equipment ($260/day), analysis ($600 for 3 samples), shipping ($40/day), and labor ($300/day).

3. Temporary fence quantity represents the additional fencing needed to completely enclose and secure the various work areas. It is assumed that existing fence will be utilized, to the extent practicable.

4. Decontamination area is assumed to be an approximately 50-foot by 50-foot area, which consists of 18 inches of gravel underlain with a 40-mil high density polyethylene liner cushioned on both sides by a 12-ounce non-woven geotextile. Decontamination area is assumed to be sloped to a sump for collection of decontamination fluids.

5. Temporary access road unit cost is based on an assumed 1,900 foot-long, 24 foot-wide, 6-inch-thick gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600X). Gravel unit cost ($36/cubic yard) is based on a $17 per ton gravel cost (delivered), a 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard), and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600X) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

6. Clearing and grubbing unit cost is based on cutting and chipping of medium trees 12 to 18 inches in diameter and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system. Total clearing and grubbing area was estimated from aerial photos.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL. The estimated cost to drive, extract, and salvage the steel sheeting is estimated to be approximately $20 per square foot, based on RS Means. An additional $20,000 is included to account for the estimated total cost of installing an access road to facilitate sheeting installation with a crane. This line item also includes approximately $1,750,000 of temporary steel sheeting to facilitate soil removal activities within the Goodwill and Alcott Street Parking Lot areas. Given the anticipated depth of excavation in this area (i.e., 20 feet below ground surface) combined with the proximity of the building adjacent to the Goodwill Parking Lots, sheeting will likely be required. Special methods will also be required to drive the sheets while minimizing the potential for damage to the adjacent structure (e.g., trenching and pre-drilling, pile driving using low vibratory methods, crack, vibration, and settlement monitoring). Estimated cost is based on approximately 35,000 square feet of sheeting at $50 per square foot to procure, install, and extract the sheet piles.

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Table 5-8 - Cost Estimate for Remedial Alternative 5B

8. Cost includes an assumed cost of $15,000 to upgrade the capacity of the existing water treatment system and a monthly maintenance cost of $5,000 to account for additional maintenance needs associated with construction activities for the first 3 years of construction. After the first 3 years, it is assumed that the existing onsite water treatment system will be decommissioned as it is located within the soil removal area. For the remaining 2 1/3 years of construction, it is assumed that a temporary onsite water treatment system will be utilized (see Item 9 below).

9. Estimated cost for temporary on-site water treatment system is based on the assumption that the existing onsite water treatment system will no longer be available for use following the first 3 years of construction. Estimated cost is based on one mobilization/demobilization.

10. Utility protection/relocation cost includes the estimated cost to relocate up to 7 electrical poles ($10,000/pole) around the removal and consolidation areas. In addition, the cost includes approximately $30,000 for the estimated expenses associated with relocation/replacement of miscellaneous onsite utilities (e.g., electrical line to the onsite water treatment facility, existing piping).

11. Temporary stormwater management and erosion and sedimentation controls include temporary sediment controls (e.g., silt fence, haybales, filter socks, and stone check dams), miscellaneous water management (e.g., pumping of collected water to water treatment system, temporary piping/culverts), temporary seeding, and dust controls. In addition, unit cost includes maintenance costs for an approximately 2-year duration.

12. Well abandonment includes the abandonment of existing monitoring wells, piezometers, and seep wells located within the footprint of the conceptual consolidation and stormwater basin areas.

13. Survey cost includes stake-out activities associated with excavation, construction, and confirmation sampling activities.

14. Cost for removal and segregation of clean soil cover materials is based on the assumption that approximately 90,000 cubic yards of clean soil cover currently exists on top of the Bryant HRDL/FRDLs, and would be removed and segregated for subsequent use as backfill.

15. Soil removal and processing/loading into disposal containers quantity represents the total quantity of in-situ material requiring excavation prior to offsite transportation and disposal. Soil removal cost includes excavation and loading of PCB-containing materials, as well as soil processing/handling. The immobilization component of this alternative would be finalized during design, but would likely include augmentation with cement (see Note 16 below) to immobilize the materials. Such processing/handling is intended to remove free liquids in order to pass USEPA paint filter test and bind the PCBs into a monolith prior to offsite transportation and disposal. Estimated quantities are as follows:

    - 635,000 cubic yards: Bryant HRDL/FRDLs
    - 170,100 cubic yards: Monarch HRDL (including Former Raceway Channel)
    - 405,000 cubic yards: Former Type III Landfill
    - 274,400 cubic yards: Western Disposal Area (including Panelyte Property, Panelyte Marsh, and Conrail Property)
    - 80,100 cubic yards: Commercial Properties (including Goodwill Lawn Area, Goodwill Parking Lots, Consumers Power, and Alcott Street Parking Lot)
    - 10,900 cubic yards: Residential/MHLLC Properties (including Golden Age)

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Table 5-8 - Cost Estimate for Remedial Alternative 5B

16. Estimated cost is based on the addition of 6% cement by volume of soil subject to offsite disposal. This stabilizing agent is intended to solidify/immobilize the soil, but also allow it to be excavateable for purposes of loading and transporting in offsite disposal containers.

17. Estimated cost to torch-cut sheetpile wall assumes that the existing sheetpile wall along the Bryant HRDL/FRDLs will be cut to at least 2 feet below final grade (final grade to be determined during design phase). Estimated cost includes approximately $7.00 per linear foot to excavate soils along the sheetpile wall to allow access for cutting, $5.00 per linear foot to cut the steel sheetpile, and approximately $18.00 per linear foot to operate and maintain a crane onsite to handle and stage the removed sheetpiles (unit cost derived from assumed 15 days of cutting at approximately $3,000 per day for a crane). No costs for offsite transportation and disposal are includes as it is assumed that such costs will be offset by the salvage/re-sale value of the removed sheetpiles.
18. Confirmation sample quantity assumes that all soil removal areas (approximately 65 acres or 2,830,000 square feet), will be sampled on a 50 foot by 50 foot grid to confirm removal of PCB-containing material. Sampling costs are assumed to be the same as the costs for analyses (i.e., $180/sample for analysis; therefore, $180 x 2 = $360 for sampling and analysis).

19. Offsite transportation and disposal cost for TSCA material is based on the assumption that approximately 33% of the soil removed from the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL will require offsite transportation and disposal as TSCA material, and all remaining soils will be managed as non-TSCA (see Note 19 below). Estimated quantity also factors in additional weight from cement stabilizing agent. Unit cost is based on a disposal rate of $85/ton and a transportation rate of $35/ton. In-place material density is assumed to be approximately 120 pounds per cubic foot (1.6 tons/cubic yard).

20. Offsite transportation and disposal cost for Non-TSCA material is based on the assumption that approximately 66% of the soil removed from the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL will require offsite transportation and disposal as Non-TSCA material, and all of the excavated soils associated with the Commercial (Goodwill Lawn Area, Goodwill Parking Lot, Consumers Power, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age), will also require segregation and offsite disposal as Non-TSCA. Estimated quantity also factors in additional weight from cement stabilizing agent. Unit cost is based on a disposal rate of $15/ton and a transportation rate of $15/ton. In-place material density is assumed to be approximately 120 pounds per cubic foot (1.6 tons/cubic yard).
21. As-built survey consists of a detailed topographic and feature survey of the disturbed area. As-built survey cost includes both field and office support costs.

22. Estimated cost for backfill is partially based on calculation, as it provides for an estimate of the volume of clean fill material that will be required to backfill the soil removal areas associated with the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL to appropriate subgrade elevation. Actual volume to be determined during design phase. The estimated cost for backfill also assumes that the voids created by removal of PCB-containing soil from the Commercial (Goodwill Lawn Area, Goodwill Parking Lots, Consumers Power, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age) will be replaced with clean backfill to within 6 inches of pre-existing grades (allowing for subsequent topsoil placement).

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Table 5-8 - Cost Estimate for Remedial Alternative 5B

23. Topsoil quantity is based on covering approximately 65 acres of soil removal area with 6 inches of topsoil. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement.

24. Seed and mulch quantity is based on covering the 65 acres of topsoil placed over the soil removal areas, as necessary to promote vegetative growth. Unit cost (i.e., $3,500/acre) was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

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Table 5-9 - Cost Estimate for Remedial Alternative 6

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1.	Pre-Construction Field Survey	1	LS	$60,000	$60,000
2.	Air Monitoring Program	2,600	DAY	$1,200	$3,120,000
3.	Temporary Fencing	1	LS	$10,000	$10,000
4.	Decontamination Area	1	EA	$35,000	$35,000
5.	Temporary Construction Access Roads	1	LS	$500,000	$500,000
6.	Clearing & Grubbing	20	AC	$9,000	$180,000
7.	Temporary Steel Sheeting	1	LS	$2,160,000	$2,160,000
8.	Upgrade of Existing Water Treatment System and Monthly Maintenance Associated with Construction	1	LS	$195,000	$195,000
9.	Temporary Water Treatment System	350	WK	$15,000	$5,250,000
10.	Utility Protection / Relocation	1	LS	$100,000	$100,000
11.	Temporary Stormwater Management and Erosion and Sediment	1	LS	$420,000	$420,000
12.	Well Abandonment	18	EA	$500	$9,000
				Site Preparation Subtotal:	**$12,039,000**
Excavation and Consolidation					
13.	Survey	60	WK	$8,600	$516,000
14.	Soil Removal & Onsite Transport to Temporary Staging Area(s)	1,485,500	CY	$5	$7,427,500
15.	Removal & Segregation of Clean Soil Cover from Bryant HRDL/FRDLs	90,000	CY	$3	$270,000
16.	Loading & Onsite Transport of Soils from Temporary Staging Area(s) to Consolidation Area(s) for Placement	1,114,125	CY	$8	$8,913,000
17.	Soil Removal & Processing/Loading into Disposal Containers	462,375	CY	$8	$3,699,000
18.	Torch-Cut Sheetpile Wall to 2 Feet Below Final Grade	2,600	LF	$30	$78,000
19.	Confirmation Sampling	280	EA	$360	$100,800
				Excavation and Consolidation Subtotal:	**$21,004,300**
Offsite Transportation & Disposal					
20.	Offsite Transportation & Disposal - Non-TSCA	739,800	TN	$30	$22,194,000
				Off-Site Transportation & Disposal Subtotal:	**$22,194,000**
Base Liner System					
21.	Grade Verification Surveys	16	WK	$8,600	$137,600
22.	Soil Grading Layer (Select Fill)	809,000	CY	$20	$16,180,000
23.	Secondary Geosynthetic Clay Liner (GCL)	291,000	SY	$3.50	$1,018,500
24.	Secondary 40-Mil Flexible Membrane Liner (FML)	242,500	SY	$13	$3,152,500
25.	Primary GCL	291,000	SY	$3.50	$1,018,500
26.	Primary FML	242,500	SY	$13.00	$3,152,500
27.	Geosynthetic Drainage Composite (GDC) Layer	291,000	SY	$5	$1,455,000
28.	Soil Protection/Drainage Layer	80,900	CY	$20	$1,618,000
29.	Pumpable Sump System	1	LS	$500,000	$500,000
30.	Leak Detection System	1	LS	$100,000	$100,000
				Base Liner System Subtotal:	**$28,332,600**
Final Cover System					
31.	Grade Verification Surveys	16	WK	$8,600	$137,600
32.	Soil Grading Layer (Select Fill)	40,400	CY	$20	$808,000
33.	Geotextile Separation Layer (8-oz/sy)	291,000	SY	$2.25	$654,750
34.	Gas Venting Layer (Sand)	81,000	CY	$20	$1,620,000
35.	Passive Gas Vents	60	EA	$750	$45,000
36.	30-mil PVC Liner	242,500	SY	$6.40	$1,552,000
37.	Geotextile Cushion Layer (16-oz/sy)	291,000	SY	$4.25	$1,236,750
38.	Soil Protection / Drainage Layer (Sand)	161,600	CY	$20	$3,232,000
39.	Topsoil Layer	40,400	CY	$30	$1,212,000
40.	Seed & Mulch	50	AC	$3,500	$175,000
				Final Cover System Subtotal:	**$10,673,100**

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Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
Permanent Storm Water Management					
41.	Vegetated Swales	16,500	LF	$15	$247,500
42.	Riprap-Lined Swales	6,750	LF	$100	$675,000
43.	Riprap Slope Protection	1	LS	$660,000	$660,000
44.	Culverts	1,600	LF	$20	$32,000
45.	Subsurface Drain Piping	7,000	LF	$45	$315,000
46.	Stormwater Basins	5	EA	$60,000	$300,000
				Permanent Storm Water Management Subtotal:	**$2,229,500**
Restoration					
47.	As-Built Survey	6	WK	$8,600	$51,600
48.	Backfill	78,000	CY	$20	$1,560,000
49.	Topsoil	13,000	CY	$30	$390,000
50.	Seed & Mulch	16	AC	$3,500	$56,000
51.	Permanent Gravel Access Roads	1	LS	$500,000	$500,000
				Restoration Subtotal:	**$2,557,600**
Post-Closure Monitoring Features Installation					
52.	Installation of Permanent Gas Monitoring Probes	6	EA	$5,000	$30,000
53.	Installation of Perimeter Gas Venting Trenches	19,250	SF	$35	$673,750
54.	Installation of Post-Closure Groundwater Monitoring Well Network	20	EA	$5,000	$100,000
				Post-Closure Monitoring Features Installation Subtotal:	**$803,750**
				CAPITAL COST SUBTOTAL:	**$99,833,850**
				Mobilization/Demobilization (7.5% of Subtotal Capital Cost):	**$7,487,539**
				Administration, Engineering, and Construction Oversight (15% of Subtotal Capital Cost):	**$14,975,078**
				Independent Construction Quality Assurance (15% of Base Liner & Final Cover System Capital Costs):	**$5,850,855**
				Contingency (20% of Subtotal Capital Cost):	**$19,966,770**
				TOTAL CAPITAL COST:	**$148,114,091**
II. OPERATION AND MAINTENANCE (O&M) COSTS					
Post-Closure Inspections & Maintenance					
55.	Years 1-5	5	YR	$100,000	$500,000
56.	Years 6-30	1	LS	$290,000	$290,000
				Post-Closure Inspections & Maintenance Subtotal:	**$790,000**
Post-Closure Landfill Gas Monitoring & Reporting					
57.	Years 1-5	5	YR	$4,000	$20,000
58.	Years 6-30	1	LS	$24,000	$24,000
				Post-Closure Landfill Gas Monitoring & Reporting Subtotal:	**$44,000**
Post-Closure Groundwater Sampling & Reporting					
59.	Years 1-5	5	YR	$250,000	$1,250,000
60.	Years 6-30	1	LS	$1,500,000	$1,500,000
				Post-Closure Groundwater Sampling & Reporting:	**$2,750,000**
				O&M COST SUBTOTAL:	**$3,584,000**
				Contingency (20% of Subtotal O&M Cost):	**$716,800**
				TOTAL O&M COST:	**$4,300,800**
				TOTAL ESTIMATED COST:	**$152,414,891**
				ROUNDED TO:	**$152,400,000**

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General Notes:

A. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

B. Unit prices are based on 2009 dollars.

C. All volumes represent in-place measures.

D. Where not otherwise noted, unit cost is based on past project experience.

E. The total conceptual consolidation/cover system area is approximately 50 acres, subdivided as follows:

- 22 acres: Bryant HRDL/FRDLs
- 10 acres: Former Type III Landfill
- 12 acres: Western Disposal Area
- 6 acres: Monarch HRDL

F. The total area of PCB-containing soil (i.e., consolidation/cover system area as well as peripheral and outlying soil removal areas) is approximately 65 acres, subdivided as follows:

- 22.1 acres: Bryant HRDL/FRDLs
- 13.6 acres: Former Type III Landfill
- 15.6 acres: Western Disposal Area (including Panelyte Property, Panelyte Marsh, and Conrail Property)
- 6.9 acres: Monarch HRDL (including Former Raceway Channel)
- 4.8 acres: Commercial Properties (i.e., Goodwill Parking Lots, Goodwill Lawn Area, Consumers Power, and Alcott Street Parking Lot)
- 1.5 acres: Residential/MHLLC-Owned Properties (including Golden Age)

G. Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown). Given the extended anticipated duration of this remedial alternative (i.e., approximately 10 years), the estimated percentage attributable to this item was increased from 5% to 7.5%.

H. "RS Means" refers to RS Means Heavy Construction Cost Data 2009.

I. "Aerial Photos" refers to images obtained from Microsoft® Live Search website (http://maps.live.com).

J. CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton WK=Week; MO=Month.

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Notes:

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking OU features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during PCB-containing material handling only (e.g., excavation, consolidation, subgrade preparation), the duration of which is assumed to be approximately 10 years total. It is also assumed that 3 PCB PolyUrethane Foam (PUF) samples will be collected per day (i.e., one-sample up-wind and two down-wind samples). Air monitoring unit cost includes the preliminary estimated cost of the rental equipment ($260/day), analysis ($600 for 3 samples), shipping ($40/day), and labor ($300/day).

3. Temporary fence quantity represents the additional fencing needed to completely enclose and secure the various work areas. It is assumed that existing fence will be utilized, to the extent practicable.

4. Decontamination area is assumed to be an approximately 50-foot by 50-foot area, which consists of 18 inches of gravel underlain with a 40-mil high density polyethylene liner cushioned on both sides by a 12-ounce non-woven geotextile. Decontamination area is assumed to be sloped to a sump for collection of decontamination fluids.

5. Temporary access road unit cost is based on an assumed 1,900 foot-long, 24 foot-wide, 6-inch-thick gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600X). Gravel unit cost ($36/cubic yard) is based on a $17 per ton gravel cost (delivered), a 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard), and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600X) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer. However, given the extended project duration and the likely need for multiple access roads, constructed and removed several times, the estimated cost for this item was increased by 5 times.

6. Clearing and grubbing unit cost is based on cutting and chipping of medium trees 12 to 18 inches in diameter and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system. Total clearing and grubbing area was estimated from aerial photos.

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7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL. The estimated cost to drive, extract, and salvage the steel sheeting is estimated to be approximately $20 per square foot, based on RS Means. An additional $20,000 is included to account for the estimated total cost of installing an access road to facilitate sheeting installation with a crane. This line item also includes approximately $1,750,000 of temporary steel sheeting to facilitate soil removal activities within the Goodwill and Alcott Street Parking Lot areas. Given the anticipated depth of excavation in this area (i.e., 20 feet below ground surface) combined with the proximity of the building adjacent to the Goodwill Parking Lots, sheeting will likely be required. Special methods will also be required to drive the sheets while minimizing the potential for damage to the adjacent structure (e.g., trenching and pre-drilling, pile driving using low vibratory methods, crack, vibration, and settlement monitoring). Estimated cost is based on approximately 35,000 square feet of sheeting at $50 per square foot to procure, install, and extract the sheet piles.

8. Cost includes an assumed cost of $15,000 to upgrade the capacity of the existing water treatment system and a monthly maintenance cost of $5,000 to account for additional maintenance needs associated with construction activities for the first 3 years of construction. After the first 3 years, it is assumed that the existing onsite water treatment system will be decommissioned as it is located within the soil removal area. For the remaining 7 years of construction, it is assumed that a temporary onsite water treatment system will be utilized (see Item 9 below).

9. Estimated cost for temporary onsite water treatment system is based on the assumption that the existing onsite water treatment system will no longer be available for use following the first 3 years of construction. Estimated cost is based on one mobilization/demobilization.

10. Utility protection/relocation cost includes the estimated cost to relocate up to 7 electrical poles ($10,000/pole) around the removal and consolidation areas. In addition, the cost includes approximately $30,000 for the estimated expenses associated with relocation/replacement of miscellaneous onsite utilities (e.g., electrical line to the onsite water treatment facility, existing piping).

11. Temporary stormwater management and erosion and sedimentation controls include temporary sediment controls (e.g., silt fence, haybales, filter socks, and stone check dams), miscellaneous water management (e.g., pumping of collected water to water treatment system, temporary piping/culverts), temporary seeding, and dust controls. In addition, unit cost includes maintenance costs for an approximately 2-year duration.

12. Well abandonment includes the abandonment of existing monitoring wells, piezometers, and seep wells located within the footprint of the conceptual consolidation and stormwater basin areas.

13. Survey cost includes stake-out activities associated with excavation, consolidation, construction, and confirmation sampling activities.

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14. Soil removal and Onsite Transport to Temporary Staging Area(s) quantity represents the total quantity of in-situ material requiring excavation and temporary onsite staging prior to re-consolidation within the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL consolidation areas. Soil removal and consolidation cost includes excavation and loading of PCB-containing materials and onsite transport to temporary staging area(s). Estimated quantities are based on removal and consolidation of approximately 635,000 cubic yards from the Bryant HRDL/FRDLs, 405,000 cubic yards from the Former Type III Landfill, 274,400 cubic yards from the Western Disposal Area (including the Panelyte Property, Panelyte Marsh, and Conrail Property), and approximately 171,100 cubic yards from the Monarch HRDL.

15. Cost for removal and segregation of clean soil cover materials is based on the assumption that approximately 90,000 cubic yards of clean soil cover currently exists on top of the Bryant HRDL/FRDLs, and would be removed and segregated for subsequent use as backfill.

16. Loading and onsite transport of soils from temporary staging area(s) to consolidation area(s) for placement quantity represents the total quantity of material that had been excavated and temporarily staged under Note 14 above, being transported back to its respective source area for consolidation. Estimated cost includes excavation and loading of PCB-containing materials, onsite transport to placement area within the consolidation areas, and placement and compaction in 12-inch lifts within the consolidation areas. Estimated quantities are based on re-consolidation of approximately 75% of the soils removed and temporarily staged in Note 14 above, accounting for the fact that certain soils will be volumetrically displaced as a result of importing clean backfill to raise the base liner system for each consolidation area to 10 feet above the water table, air space lost to imported base liner and cover system materials, as well as space constraints driven by maintaining appropriate slopes and grades along the final surface.

17. Soil removal and processing/loading into disposal containers quantity represents the total quantity of in-situ material requiring excavation prior to off-site transportation and disposal. Soil removal cost includes excavation and loading of PCB-containing materials, as well as soil stabilization. Means of soil stabilization are unknown and may include temporary staging to allow for gravity dewatering, onsite soil mixing, and/or augmentation with a stabilizing agent (e.g., cement kiln dust or fly ash). Estimated quantities are based on removal and offsite disposal of the approximately 25% of soils volumetrically displaced from the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL, as well as approximately 91,000 cubic yards of PCB-containing soil from the Commercial Properties (Goodwill Lawn Area, Goodwill Parking Lots, Consumers Power only, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age).

18. Estimated cost to torch-cut sheetpile wall assumes that the existing sheetpile wall along the Bryant HRDL/FRDLs will be cut to at least 2 feet below final grade (final grade to be determined during design phase). Estimated cost includes approximately $7.00 per linear foot to excavate soils along the sheetpile wall to allow access for cutting, $5.00 per linear foot to cut the steel sheetpile, and approximately $18.00 per linear foot to operate and maintain a crane onsite to handle and stage the removed sheetpiles (unit cost derived from assumed 15 days of cutting at approximately $3,000 per day for a crane). No costs for offsite transportation and disposal are includes as it is assumed that such costs will be offset by the salvage/re-sale value of the removed sheetpiles.

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19. Confirmation sample quantity assumes that removal areas, located outside of the conceptual consolidation area (approximately 16 acres or 700,000 square feet), will be sampled on a 50 foot by 50 foot grid to confirm removal of PCB-containing material. Sampling costs are assumed to be the same as the costs for analyses (i.e., $180/sample for analysis; therefore, $180 x 2 = $360 for sampling and analysis).

20. Offsite transportation and disposal cost for Non-TSCA material is based on the assumption that all of the excavated soils volumetrically displaced from the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL, as well as all of the excavated soils associated with the Commercial (Goodwill Lawn Area, Goodwill Parking Lot, Consumers Power, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age), will require segregation and offsite disposal as Non-TSCA. Unit cost is based on a disposal rate of $15/ton and a transportation rate of $15/ton. In-place material density is assumed to be approximately 120 pounds per cubic foot (1.6 tons/cubic yard).

21. Grade verification survey cost estimate includes one survey of the consolidation/base liner areas. The first survey would be performed prior to commencing base liner installation activities to verify the appropriate elevation.

22. Soil grading layer cost estimate is based on an assumed 10-foot-thick layer of select fill covering the entire areas subject to base liner installation, as required to ensure that the base liner system is a minimum of 10 feet above the groundwater table. Select fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 357,000 cubic yards: Bryant HRDL/FRDLs
    - 160,000 cubic yards: Former Type III Landfill
    - 195,000 cubic yards: Western Disposal Area
    - 97,000 cubic yards: Monarch HRDL

23. Secondary geosynthetic clay liner (GCL) cost estimate assumes utilizing a GCL as a soil-clay substitute covering the entire base liner system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on RS Means. Estimated quantities are subdivided as follows:

    - 128,400 square yards: Bryant HRDL/FRDLs
    - 58,100 square yards: Former Type III Landfill
    - 69,700 square yards: Western Disposal Area
    - 34,800 square yards: Monarch HRDL

24. Estimated cost for secondary 40-mil flexible membrane liner (FML) is based on the assumption that an impermeable liner will be placed as part of the base liner of the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL.

25. Primary GCL cost estimate assumes utilizing a GCL as a soil-clay substitute covering the entire base liner system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on RS Means. Estimated quantities are the same as those specified for the secondary GCL.

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26. Estimated cost for primary 40-mil FML is based on the assumption that an additional impermeable liner will be placed as part of the base liner of the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL.

27. Estimated cost for installation of geosynthetic drainage composite (GDC) layer is based on the assumption that a GDC layer will be placed as part of the base liner systems of the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL. The estimated quantity includes an additional 20% material quantity to account for overlap and wrinkles.

28. Soil protection/drainage layer consists of a 1-foot-thick layer of sand covering the entire base liner system area. Sand fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 35,700 cubic yards: Bryant HRDL/FRDLs
    - 16,100 cubic yards: Former Type III Landfill
    - 19,400 cubic yards: Western Disposal Area
    - 9,700 cubic yards: Monarch HRDL

29. Estimated cost for a pumpable sump system acknowledges the cost associated with collecting and managing leachate.

30. Estimated cost for a leak detection system acknowledges the cost associated with monitoring for potential leaks in the base liner system.

31. Grade verification survey cost estimate includes two surveys of the consolidation/cover system areas. The first survey would be performed prior to commencing filling activities. The second survey would be performed immediately prior to the installation of the liner system (i.e., liner subgrade survey). Each survey is assumed to take approximately eight weeks.

32. Soil grading layer cost estimate is based on an assumed 6-inch-thick layer of select fill covering the entire cover system areas and is the first layer of the impermeable final cover system. Select fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 17,800 cubic yards: Bryant HRDL/FRDLs
    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL

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33. Geotextile separation layer cost estimate assumes utilizing a non-woven geotextile covering the entire cover system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on information provided by geotextile manufacturer. Estimated quantities are subdivided as follows:

    - 128,400 cubic yards: Bryant HRDL/FRDLs
    - 58,100 square yards: Former Type III Landfill
    - 69,700 square yards: Western Disposal Area
    - 34,800 square yards: Monarch HRDL

34. Estimated cost for gas venting layer is based on the assumption that a 12-inch sand layer will be placed on top of the geotextile separation layer of the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL areas.

35. Estimated cost for passive gas vent installation is based on an installation frequency of 1.2 vents/acre within the Bryant HRDL/FRDLs, Former Type III Landfill, the Western Disposal Area, and the Monarch HRDL.

36. Estimated cost for 30-mil PVC liner is based on the assumption that an impermeable liner will be placed over the 12-inch sand layer of the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL.

37. Estimated cost for installation of geotextile cushion layer (16 oz) is based on the assumption that a geotextile layer will be placed over the 30-mil PVC liner in the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL. The estimated quantity includes an additional 20% material quantity to account for overlap and wrinkles.

38. Soil protection/drainage layer consists of a 2-foot-thick layer of sand covering the entire cover system area. Sand fill unit cost is based on a $10 per ton (1.5 tons/cubic yard) material and delivery cost and an approximate $5 per cubic yard cost for placement and compaction in 6-inch lifts. Estimated quantities are subdivided as follows:

    - 71,200 cubic yards: Bryant HRDL/FRDLs
    - 32,400 cubic yards: Former Type III Landfill
    - 38,800 cubic yards: Western Disposal Area
    - 19,200 cubic yards: Monarch HRDL

39. Topsoil layer consists of a 6-inch-thick layer of topsoil covering the entire cover system areas. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement. Estimated quantities are subdivided as follows:

    - 17,800 cubic yards: Bryant HRDL/FRDLs
    - 8,100 cubic yards: Former Type III Landfill
    - 9,700 cubic yards: Western Disposal Area
    - 4,800 cubic yards: Monarch HRDL

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40. Seed and mulch cost estimate is based on seeding and mulching the entire area subject to consolidation/final cover system. The per acre unit cost is derived based on an estimated cost of $3,500/acre, which was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

41. Total length of the vegetated swale is preliminary and partially based on a conceptual cover system layout prepared for cost estimating purposes only, and includes both perimeter swales/ditches and mid-slope swales. In addition, it is assumed that the linear foot unit cost to construct a perimeter swale is equal to the cost to construct a mid-slope swale. Vegetated swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and 2-foot-deep channel geometry. Vegetated swale unit cost includes the cost to excavate the swale ($2/cubic yard), install a 6-inch topsoil layer ($30/cubic yard), and cover with erosion control matting ($0.75/square yard).

42. Total length of the riprap-lined swale is preliminary and partially based on a conceptual cover system layout prepared for cost estimating purposes only. Riprap-lined swale unit cost is based on an assumed 3-foot bottom width, 3 on 1 sideslopes, and a 2-foot-deep channel geometry. Channel lining is assumed to consist of a 15-inch-thick layer of riprap underlain with a non-woven geotextile. Riprap-lined swale unit cost includes the cost to excavate the swale ($2/cubic yard), install the non-woven geotextile ($2.25/square yard), and install riprap ($100/cubic yard).

43. Riprap slope protection quantity is preliminary and partially based on an assumed 40-foot-wide, 2,200-foot-long, by 15-inch-thick layer of riprap installed along the southeast bank of Portage Creek to protect the toe of the cover system side slope. Riprap material and placement cost is approximately $100 per cubic yard. Non-woven geotextile (i.e., Mirafi S800) unit cost ($2.25/square yard) is based on information provided by the manufacturer.

44. Total length of culvert piping is preliminary and partially based on a conceptual cover system layout prepared for cost estimating purposes only. Unit cost ($20/linear foot) is based on an assumed 18-inch diameter high density polyethylene (HDPE) pipe, Type S, and includes material and installation costs. Unit cost was obtained from RS Means.

45. Subsurface drainage is assumed to consist of a 6-inch diameter perforated pipe ($8.45 /linear foot) and a 6-inch-thick layer of drainage stone mounded over top the pipe ($61.50/cubic yard). In addition, the perforated pipe and drainage stone are wrapped in a non-woven geotextile ($2.25/square yard). Pipe and drainage stone unit costs were obtained from RS Means, and include material and installation costs. Additional geotextile material is assumed for a full-width overlap of each side of the geotextile in the longitudinal direction.

46. Stormwater basin unit cost represents an average per basin cost, which was developed from a conceptual stormwater basin configuration. Stormwater basin unit cost includes construction of an embankment (where applicable), topsoiling and seeding of the entire basin area, and construction of a corrugated metal pipe riser outlet structure. It is preliminarily assumed that a stormwater basin will be required for each of the Former Type III landfill, Western Disposal Area, and Monarch HRDL consolidation/cover system areas, and two stormwater basins required for the Bryant HRDL/FRDLs.

47. As-built survey consists of a detailed topographic and feature survey of the disturbed area. As-built survey cost includes both field and office support costs.

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48. The estimated cost for backfill assumes that the voids created by removal of PCB-containing soil from the Commercial (Goodwill Lawn Area, Goodwill Parking Lots, Consumers Power, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age) will be replaced with clean backfill to within 6 inches of pre-existing grades (allowing for subsequent topsoil placement).

49. Topsoil quantity is based on covering approximately 16 acres of soil removal area, located outside the limits of capping, with 6 inches of topsoil. Topsoil unit cost is based on a $25 per cubic yard material and delivery cost and an approximate $5 per cubic yard cost for placement.

50. Seed and mulch quantity is based on covering the 16 acres of topsoil placed over the outlying soil removal areas, as necessary to promote vegetative growth. Unit cost (i.e., $3,500/acre) was obtained from RS Means and includes seed, mulch, and fertilizer applied by hydroseeding.

51. Permanent access road quantity based on an assumed 14,000 linear feet of newly constructed road that will be required to access various portions of the cover system area for maintenance purposes. Permanent access roads are assumed to consist of a 24 foot-wide, 1-foot-thick, gravel surface (i.e., Michigan DOT #21AA) underlain with a woven geotextile (i.e., Mirafi 600x). Access road unit cost was based on a gravel material cost of $17 per ton (delivered), an assumed 130-pound per cubic foot in-place density (i.e., 1.8 tons/cubic yard) and a $5 per cubic yard material placement cost. Woven geotextile (i.e., Mirafi 600x) material and installation cost is approximately $1.50 per square yard based on information provided by the manufacturer.

52. The estimated cost for installation of permanent gas probes is based on the assumption that a series of six permanent gas monitoring probes will be installed along perimeters of the Western Disposal Area and the Monarch HRDL to monitor landfill gas concentrations at locations adjacent to neighboring properties.

53. The estimated cost for installation of perimeter gas venting trenches is based on the assumption that 5-foot deep, 2-foot wide gas venting trenches, consisting of trenches filled with crushed stone/pea gravel and perforated piping affixed with wind turbine ventilators, will be installed along the perimeters of the Western Disposal Area and the Monarch HRDL to vent landfill gas from the subsurface before encroaching onto adjacent neighboring properties.

54. The estimated cost for installation of a post-closure groundwater monitoring network is based on the assumption that a series of groundwater monitoring wells will be installed along the entire perimeters of the Former Type III Landfill, the Western Disposal Area, and the Monarch HRDL for purposes of collecting post-closure groundwater samples.

55. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a quarterly basis for the first 5 years of the post-closure period.

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56. The estimated cost for post-closure inspections and maintenance assumes that inspections of the final cover system and ancillary OU features will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the net present value (NPV) or present worth, and is based on an annual cost of approximately $25,000 at a 7% discount rate.

57. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a quarterly basis for the first 5 years of the post-closure period.

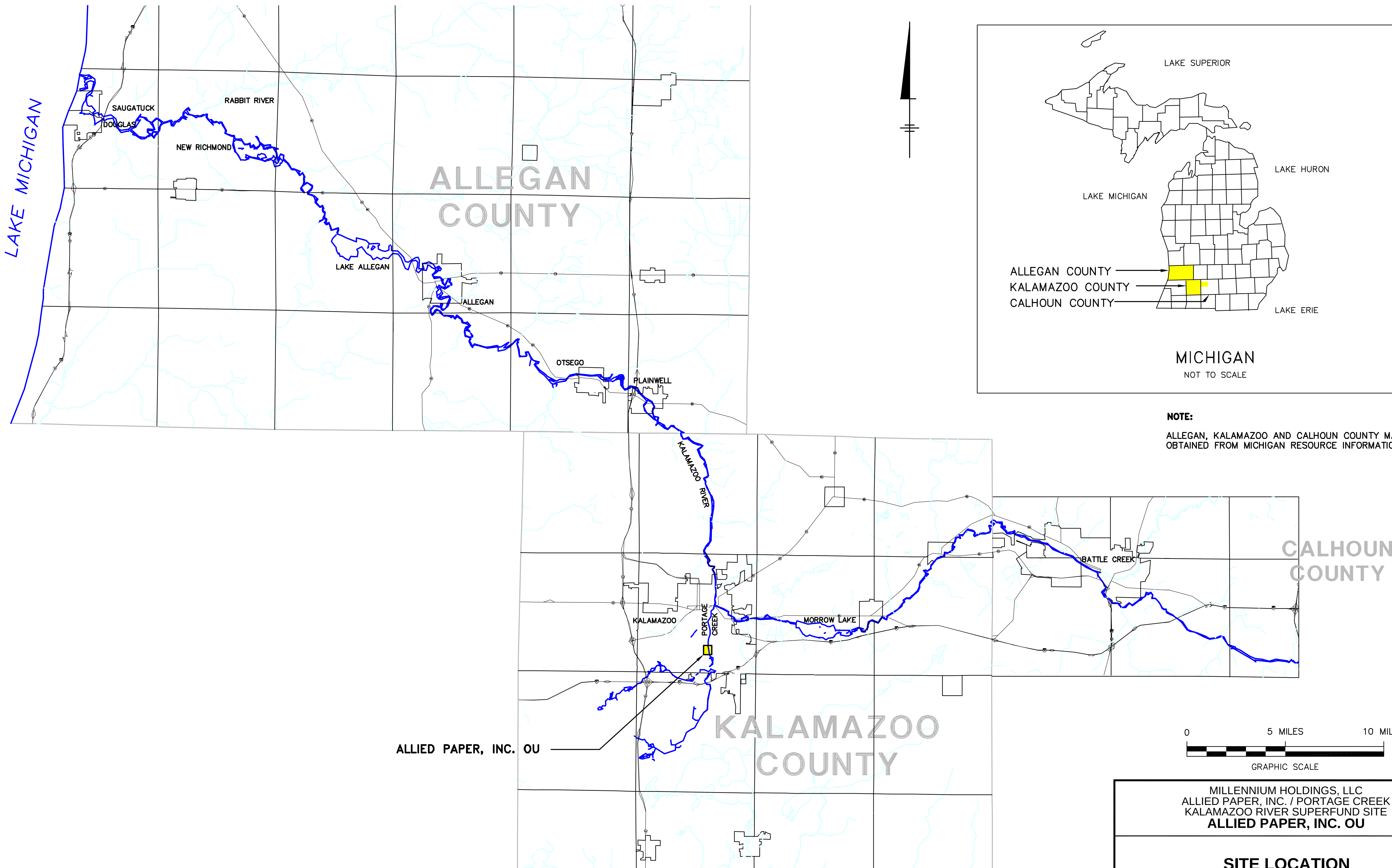
58. The estimated cost for post-closure landfill gas monitoring assumes that landfill gas monitoring will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $2,000 at a 7% discount rate.

59. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a quarterly basis for the first 5 years of the post-closure period, and will include PCB and a variety of non-PCB constituents.

60. The estimated cost for post-closure groundwater sampling assumes that groundwater sampling will be conducted on a semi-annual basis for the remaining 25 years of the post-closure period, and will include PCB and a variety of non-PCB constituents. This estimated cost represents the NPV or present worth, and is based on an annual cost of approximately $125,000 at a 7% discount rate.

ARCADIS

FIGURES



NOTE:

ALLEGAN, KALAMAZOO AND CALHOUN COUNTY MAPPING OBTAINED FROM MICHIGAN RESOURCE INFORMATION SYSTEM.

0 5 MILES 10 MILES

GRAPHIC SCALE

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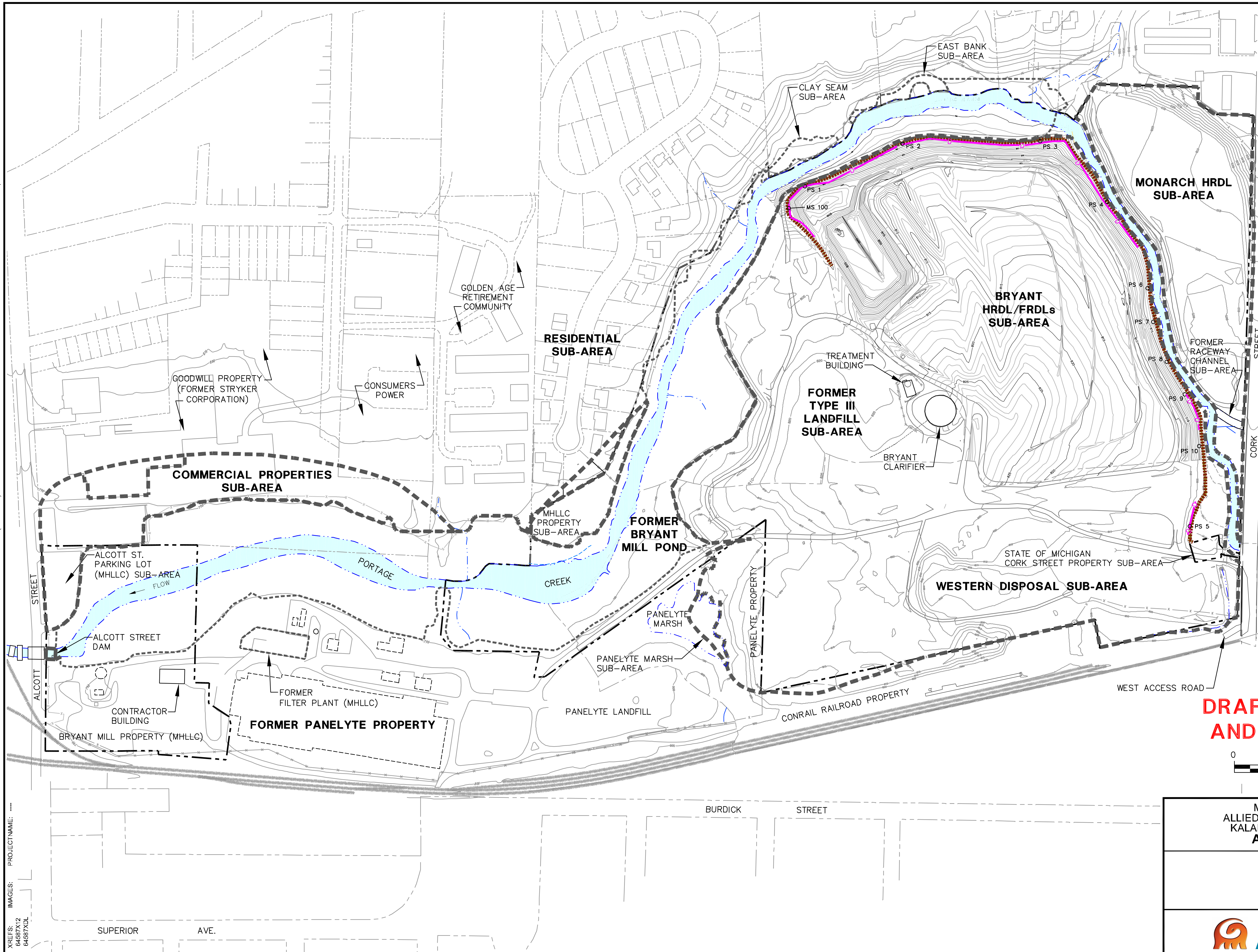
MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

SITE LOCATION

ARCADIS

FIGURE
1-1



LEGEND:

- EDGE OF WATER OR DRAINAGE CHANNEL
- TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
- BREAK LINE DELINEATING LIMITS OF VARYING TOPOGRAPHIC SURVEYS
- ROAD/TRAIL
- SHEETPILE LOCATION
- APPROXIMATE TAX MAP PROPERTY LINE
- SURVEYED PROPERTY BOUNDARY
- PS 6 O COLLECTION SUMP
- APPROXIMATE SUB-AREA BOUNDARY
- PREVIOUSLY REMEDIATED AREAS
- EXISTING DRAINAGE TRENCH (INSTALLED IN 2000 AND 2003)

NOTES:

1. TOPOGRAPHIC MAPPING NORTH OF FORMER TYPE III LANDFILL AREA, AND BRYANT HRDLs/FRDLs PRODUCED USING PHOTOGRAMETRIC METHODS BY LOCKWOOD, INC. FROM AERIAL PHOTOGRAPHY FLOWN MAY 1991. BASE MAP INFORMATION WITHIN FORMER TYPE III LANDFILL AREA AND AREA NORTH OF WESTERN DISPOSAL AREA FIELD SURVEY OBTAINED FROM PLAN ENTITLED "TOPOGRAPHIC AND BOUNDARY SURVEY OF ALLIED PAPER, INC. KALAMAZOO, MI. SECTION 27. TOWN 2 SOUTH, RANGE 11 WEST," PREPARED BY WADE-TRIM, INC., DATED 7/8/99. BASE MAP INFORMATION WITHIN BRYANT HRDLs/FRDLs AREA OBTAINED FROM PLAN ENTITLED "AS BUILT SURVEY OF ALLIED PAPER SITE" PREPARED BY PREIN AND NEWHOF, KALAMAZOO, MI. DATED 1/27/05 (PROJECT NO. 2000171K). TOPOGRAPHIC CONTOUR LINES INSIDE THE MONARCH HRDL AREA SURVEYED BY PREIN & NEWHOF SURVEYORS ON 4/03. NGVD 1929. BASE MAP INFORMATION IN THE WESTERN DISPOSAL AREA BASED ON TOPOGRAPHIC SURVEY PERFORMED BY PREIN & NEWHOF, DRAWING FILE NUMBER 2060643K, DATED SEPTEMBER 27, 2006.
2. ELEVATIONS ARE REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) 1929.
3. COORDINATE GRID IS REFERENCED TO THE MICHIGAN STATE PLANE (SOUTH ZONE) COORDINATE SYSTEM (NAD83).
4. ALLIED PROPERTY LINES ESTABLISHED USING: WADE-TRIM SURVEY (9/1999)-NORTHERN PARCEL ONLY; ATWELL HICKS, INC. SURVEY (11/2002); AND PREIN AND NEWHOF SURVEY (12/2002).
5. PORTAGE CREEK OUTLINE WITHIN THE ALLIED PROPERTY UPDATED ON 12/4/02 USING DIGITAL ORTHOGRAPHY BY AIR LAND SURVEYS, INC.(4/24/00) SCANNED FROM CDM DRAWING DETSVR/DETL007770/C:/PROJ/28963/_GIS/OU1/OU1_REPORT.APR REVISED 11/10/02. PORTAGE CREEK OUTLINE NORTH OF THE ALLIED PROPERTY UPDATED ON 12/4/02 USING A CDM CREEK OUTLINE PREPARED ON 9/23/02 PROVIDED ON COMPACT DISK.
6. GOODWILL PROPERTY OUTLINE, AND PROPERTY OUTLINES IN THE SUPERIOR AVE., HOMECREST AVE., AND BURDICK STREET AREAS WEST OF THE RAILROAD DIGITIZED FROM A PRINTOUT FROM THE CITY OF KALAMAZOO – ONLINE GIS SITE LINK ON 6/22/2009.
7. LIMITS OF REMOVAL ACTION IN THE FORMER BRYANT MILL POND DIGITIZED FROM HARD COPY OF DRAWING AS RECIEVED IN ELECTRONIC CORRESPONDENCE DATED FEBRUARY 20, 2001, FROM WESTON (D.D. HERNANDEZ) TO BBL (DKC) TRANSMITTING BMP DRAWINGS.

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0 300' 600'

GRAPHIC SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

SUB-AREAS

ARCADIS

FIGURE
1-2

CITY: SYRACUSE, NY GROUP: ENVCAD-141 DB: R. ALLEN, P. LISTER, R.ALLEN PM: T. GRANZEIER TM: C. SOBOL TR: E. DENKENBERGER LYR:ON=*;OFF=REF, (FRZ)
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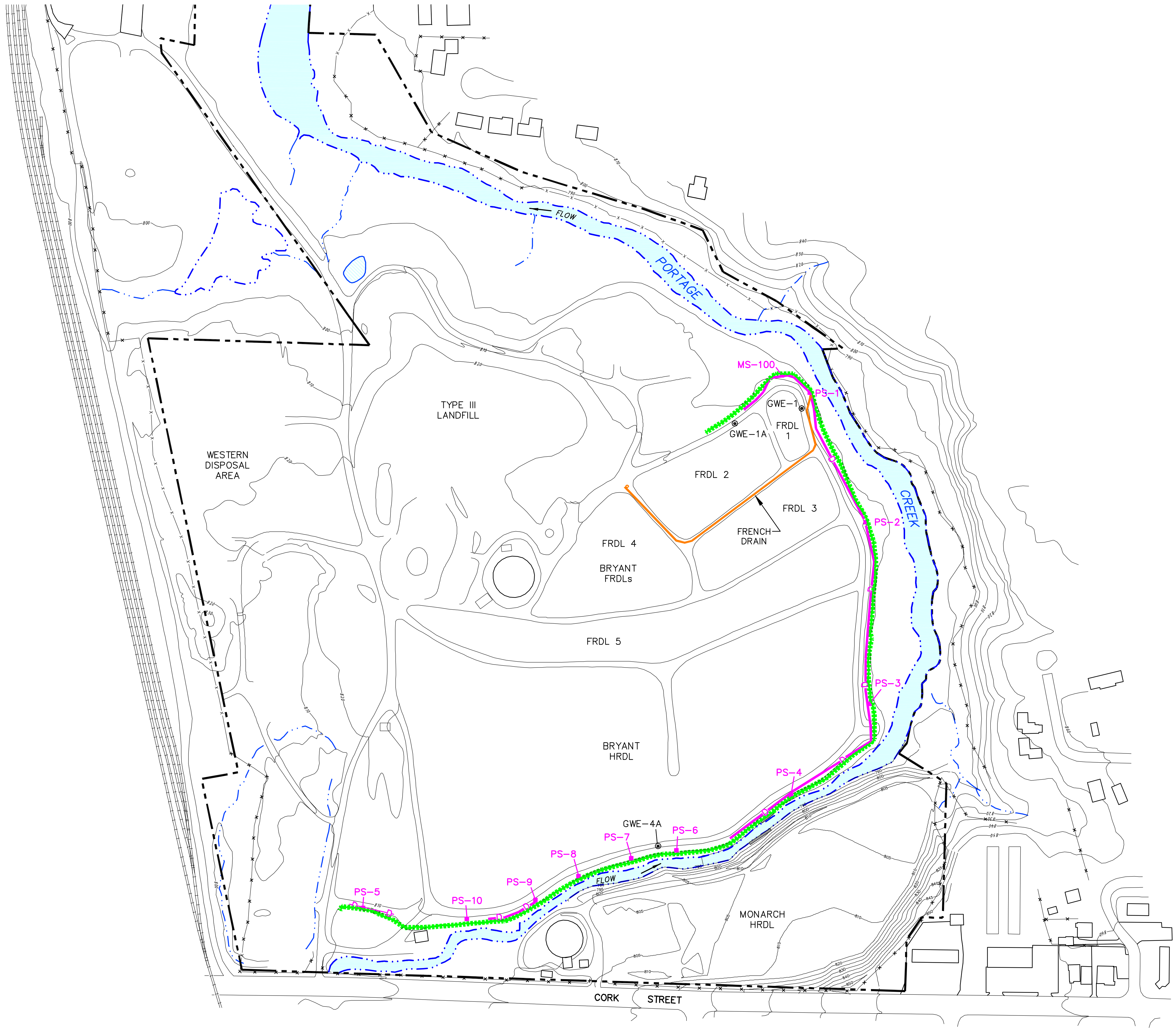

LEGEND:

- EDGE OF WATER OR DRAINAGE CHANNEL
- ROAD/TRAIL
- SHEETPILE LOCATION
- PROPERTY LINE
- GWE-1A — RECOVERY WELL LOCATION
- PS-4 — DRAINAGE SUMP
- D — EXISTING DRAINAGE TRENCH
- APPROXIMATE LOCATION OF FRENCH DRAIN

NOTES:

1. BASE MAP PREPARED USING: LOCKWOOD, INC. MAY 1991 AERIAL PHOTO; DIGITIZED COPIES OF PAPER TAX MAPS; AND PROPERTY OWNER INFORMATION FROM KALAMAZOOCITY.ORG WEBSITE.
2. ALLIED PROPERTY LINES ESTABLISHED USING: WADE-TRIM SURVEY (9/1999)-NORTHERN PARCEL ONLY; ATWELL HICKS, INC. SURVEY (11/2002); AND PREIN AND NEWHOF SURVEY (12/2002).
3. PORTAGE CREEK OUTLINE WITHIN THE ALLIED PROPERTY UPDATED ON 12/4/02 USING DIGITAL ORTHOGRAPHY BY AIR LAND SURVEYS, INC.(4/24/00) SCANNED FROM CDM DRAWING DETSVR/DETL007770/C: /PROJ/28963/_GIS/OU1/OU1_REPORT.APR REVISED 11/10/02.
4. TOPOGRAPHIC MAPPING PRODUCED USING PHOTOGRAMETRIC METHODS BY LOCKWOOD, INC FROM AERIAL PHOTOGRAPHY FLOWN MAY 1991.
5. BASE MAP LOCATED IN MICHIGAN STATE PLANE COORDINATE SYSTEM.
6. TOPOGRAPHIC CONTOUR LINES INSIDE THE MONARCH HRDL AREA SURVEYED BY PREIN & NEWHOF SURVEYORS ON 4/03. NAVD 1929.

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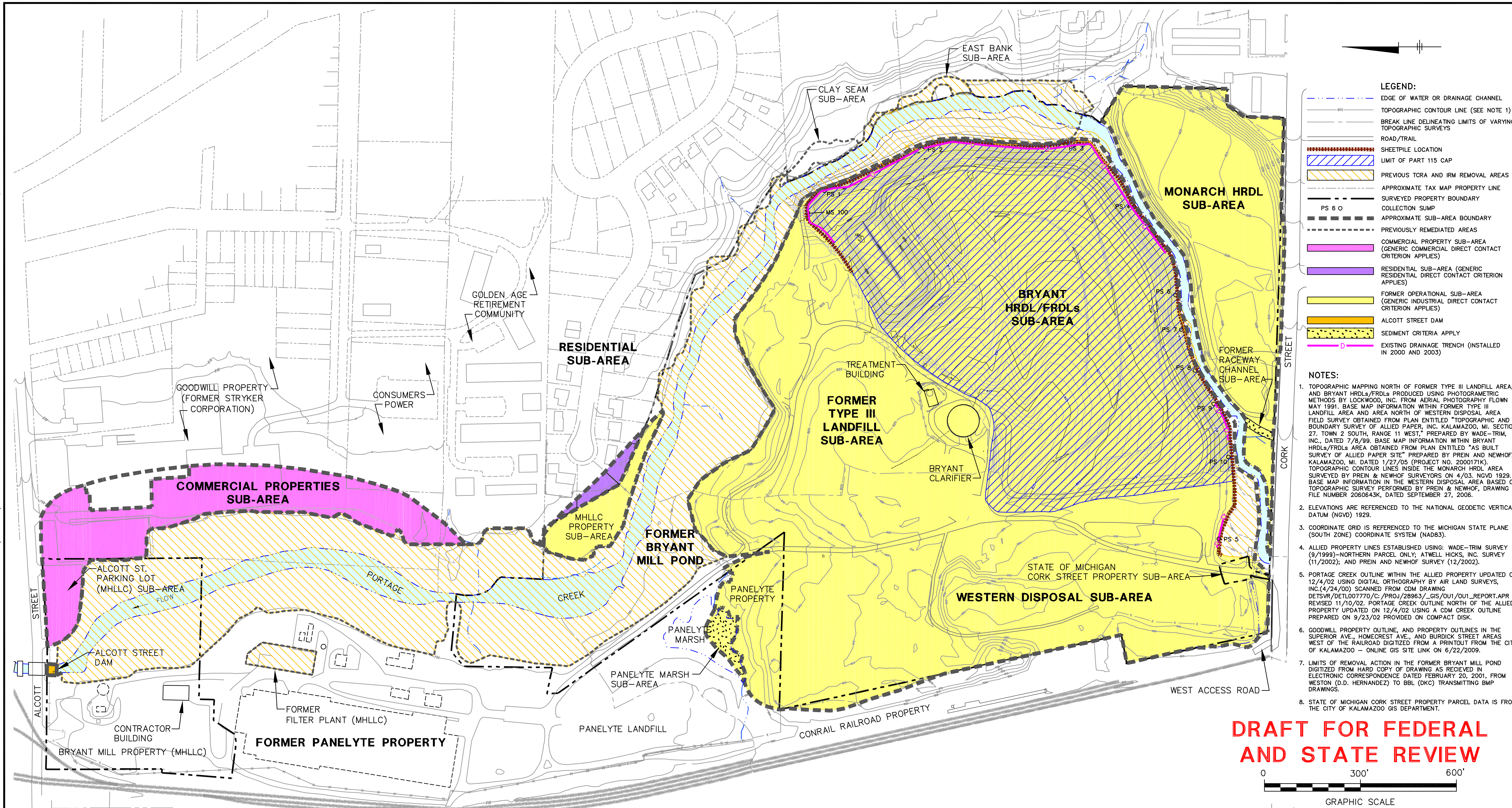
0 250' 500'
GRAPHIC SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. /PORTAGE CREEK
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GROUNDWATER EXTRACTION SYSTEM

ARCADIS

FIGURE
1-3



MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

SUB-AREAS OF OU1 TO BE CONSIDERED IN THE FS

ARCADIS

FIGURE
2-1

CITY: SYRACUSE, NY GROUP: ENVCAD-141 DB: R. ALLEN, P. LISTER, R.ALLEN PM: T. GRANZEIER TM: C. SOBOL TR: E. DENKENBERGER LYR:ON=*;OFF=REF (FRZ)
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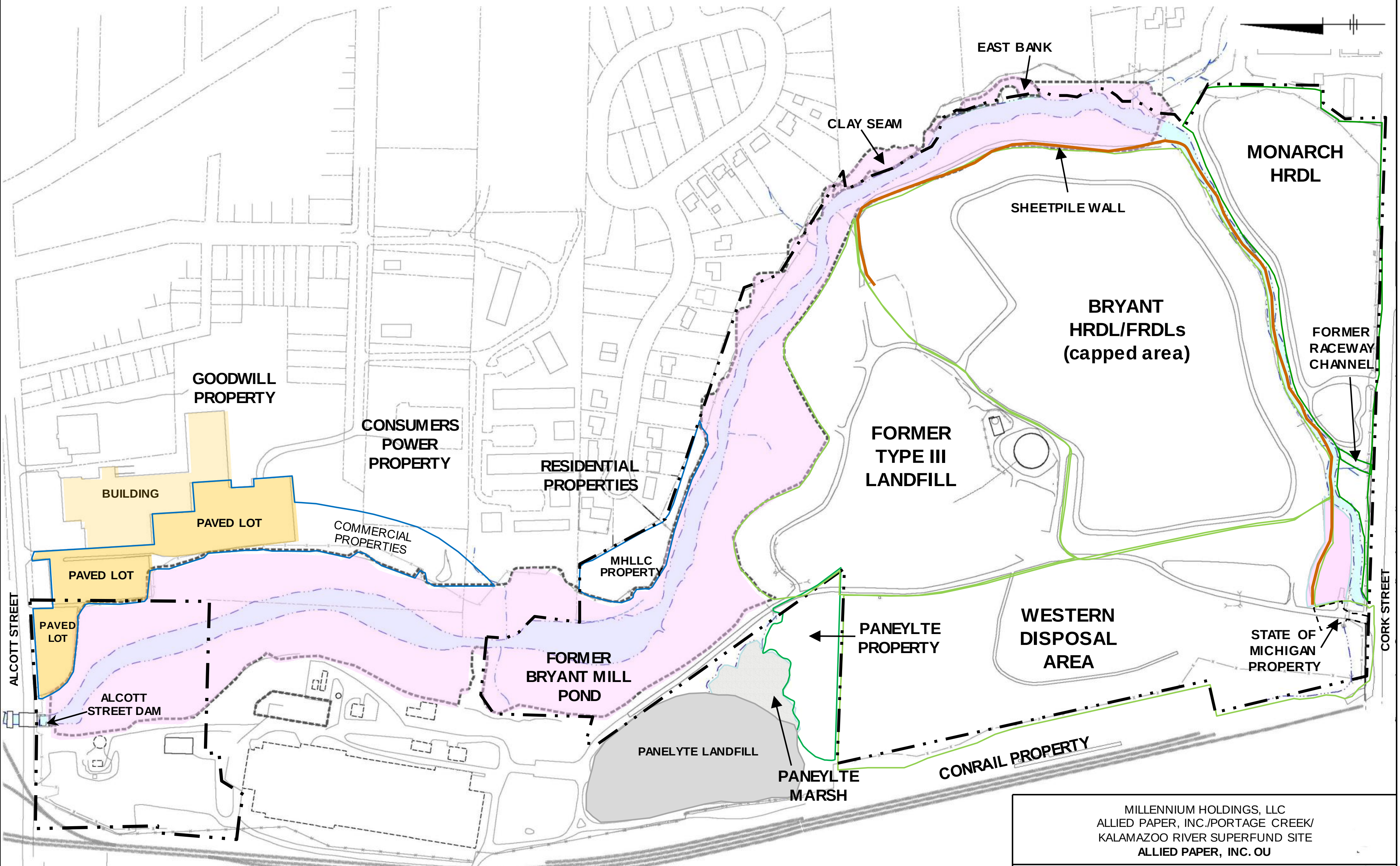

LEGEND

- Edge of Water or Drainage Channel
- Road/Trail
- Approximate Property Line from County Tax Map
- Surveyed Property Boundary
- Previously Remediated Area

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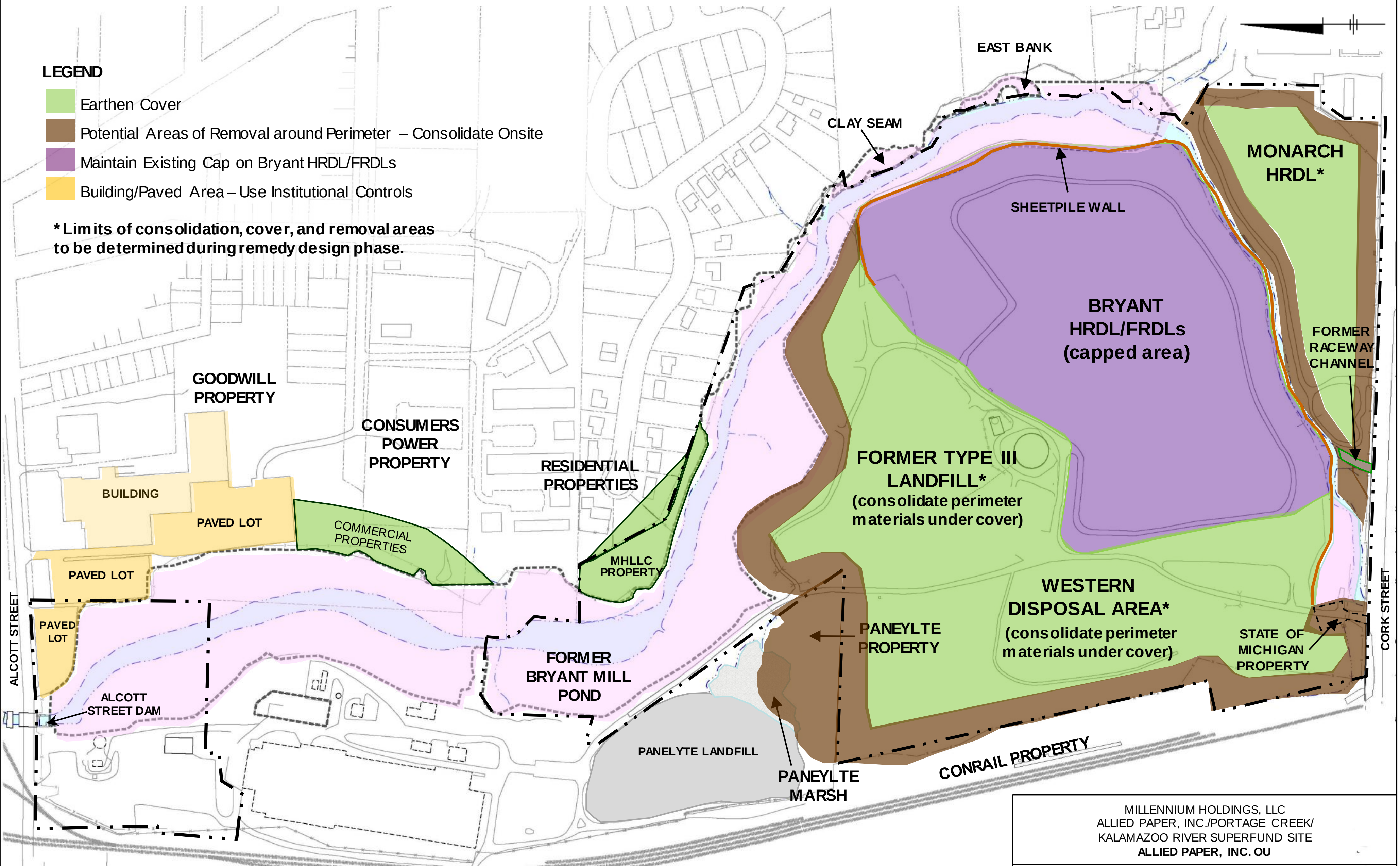
MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

ALTERNATIVE 1
No Further Action

ARCADIS

FIGURE **4-1**

MFE: AlliedOUFS_Sect4Figs.ppt



MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

ALTERNATIVE 2A
Containment of Outlying Areas and Onsite Former Operational Areas beneath Earthen Covers

ARCADIS

FIGURE 4-2

Edge of Water or Drainage Channel
Road/Trail
Approximate Property Line from County Tax Map
Surveyed Property Boundary
Previously Remediated Area

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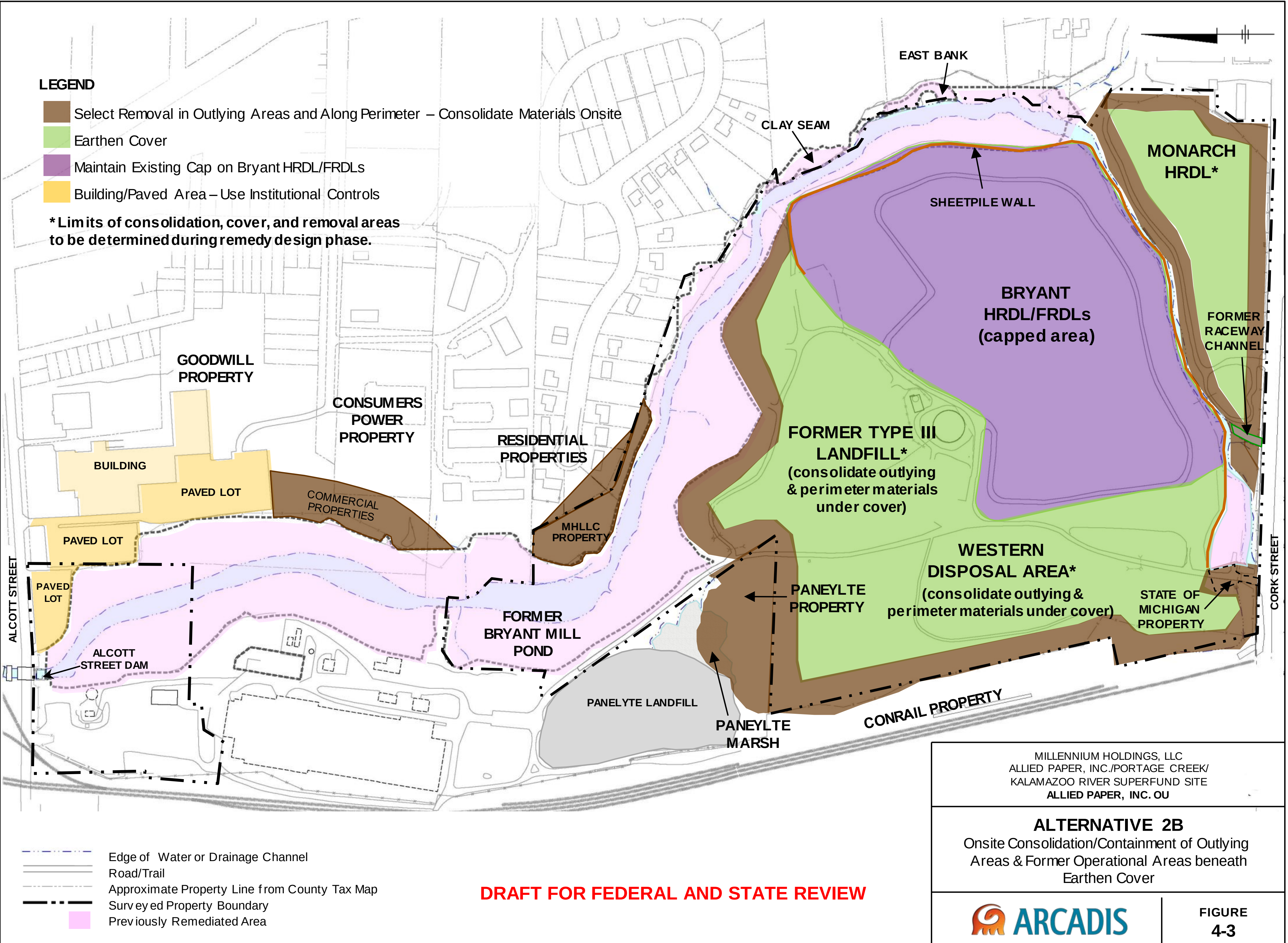
MFE: AlliedOUFS_Sect4Figs.ppt



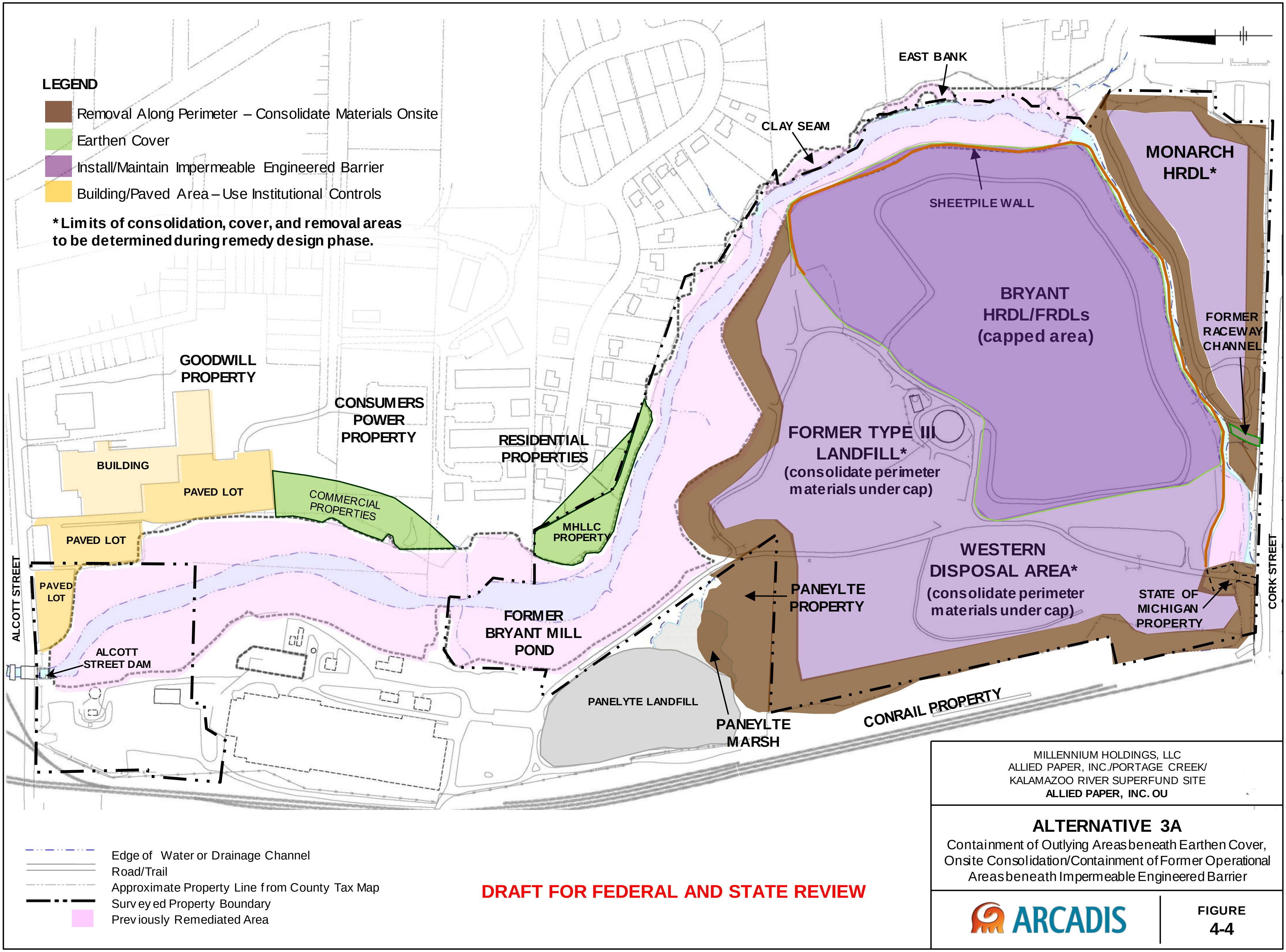
MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

ALTERNATIVE 2B
Onsite Consolidation/Containment of Outlying Areas & Former Operational Areas beneath Earthen Cover

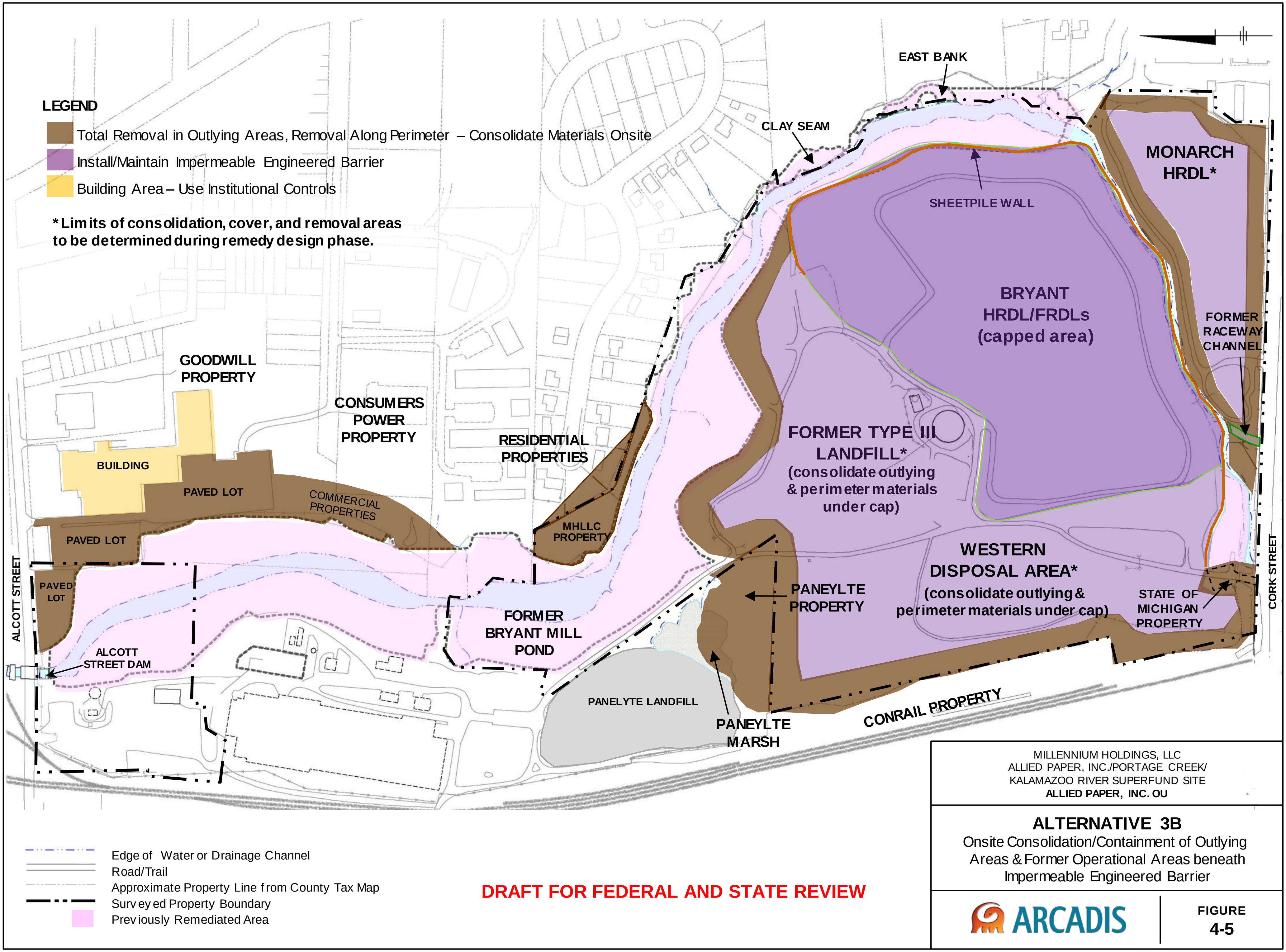
ARCADIS

FIGURE 4-3

MFE: AlliedOUFS_Sect4Figs.ppt



MFE: AlliedOUFS_Sect4Figs.ppt


LEGEND
Total Removal in Outlying Areas, Removal Along Perimeter – Consolidate Materials Onsite
Install/Maintain Impermeable Engineered Barrier
Building Area – Use Institutional Controls
* Limits of consolidation, cover, and removal areas to be determined during remedy design phase.
EAST BANK
CLAY SEAM
SHEETPILE WALL
MONARCH HRDL*
BRYANT HRDL/FRDLs (capped area)
FORMER RACEWAY CHANNEL
GOODWILL PROPERTY
CONSUMERS POWER PROPERTY
RESIDENTIAL PROPERTIES
BUILDING
PAVED LOT
COMMERCIAL PROPERTIES
PAVED LOT
MHLLC PROPERTY
FORMER TYPE III LANDFILL* (consolidate outlying & perimeter materials under cap)
WESTERN DISPOSAL AREA* (consolidate outlying & perimeter materials under cap)
PANEYLTE PROPERTY
STATE OF MICHIGAN PROPERTY
CORK STREET
ALCOTT STREET
PAVED LOT
ALCOTT STREET DAM
FORMER BRYANT MILL POND
PANELYTE LANDFILL
PANEYLTE MARSH
CONRAIL PROPERTY
Edge of Water or Drainage Channel
Road/Trail
Approximate Property Line from County Tax Map
Surveyed Property Boundary
Previously Remediated Area
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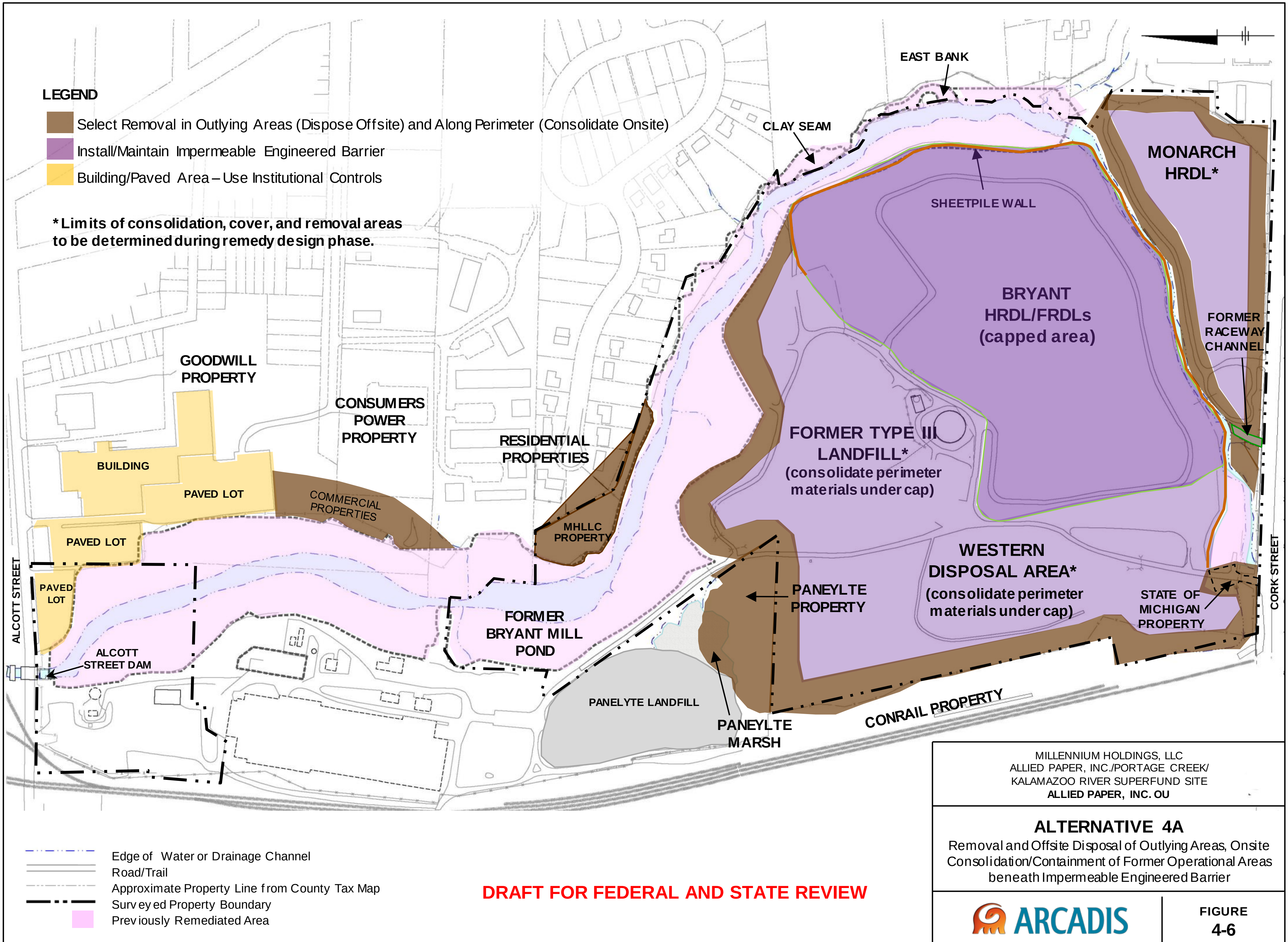
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU
ALTERNATIVE 3B
Onsite Consolidation/Containment of Outlying Areas & Former Operational Areas beneath Impermeable Engineered Barrier
ARCADIS
FIGURE 4-5



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MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

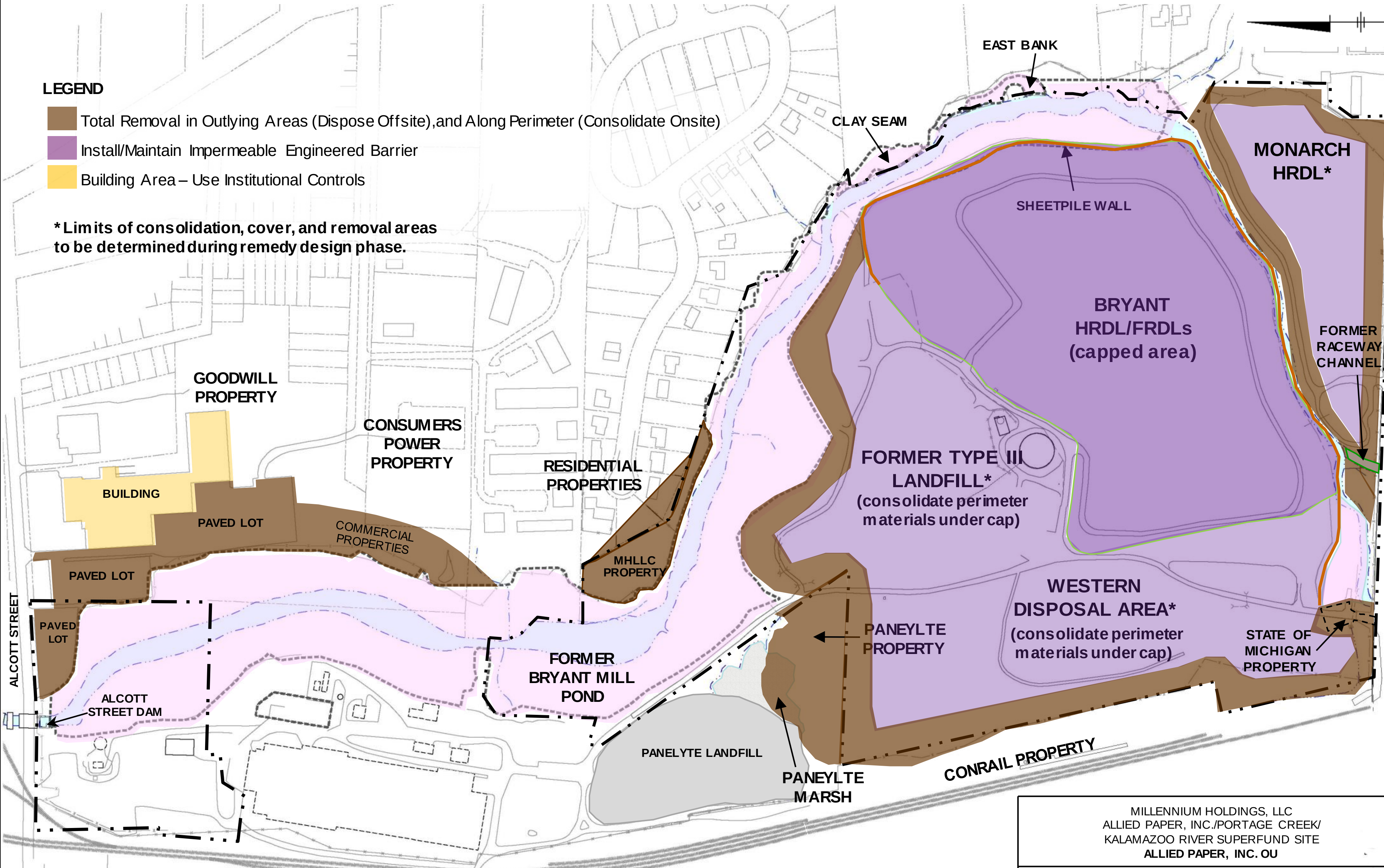
ALTERNATIVE 4A

Removal and Offsite Disposal of Outlying Areas, Onsite Consolidation/Containment of Former Operational Areas beneath Impermeable Engineered Barrier

ARCADIS

FIGURE 4-6

MFE: AlliedOUFS_Sect4Figs.ppt



- Edge of Water or Drainage Channel
- Road/Trail
- Approximate Property Line from County Tax Map
- Surveyed Property Boundary
- Previously Remediated Area

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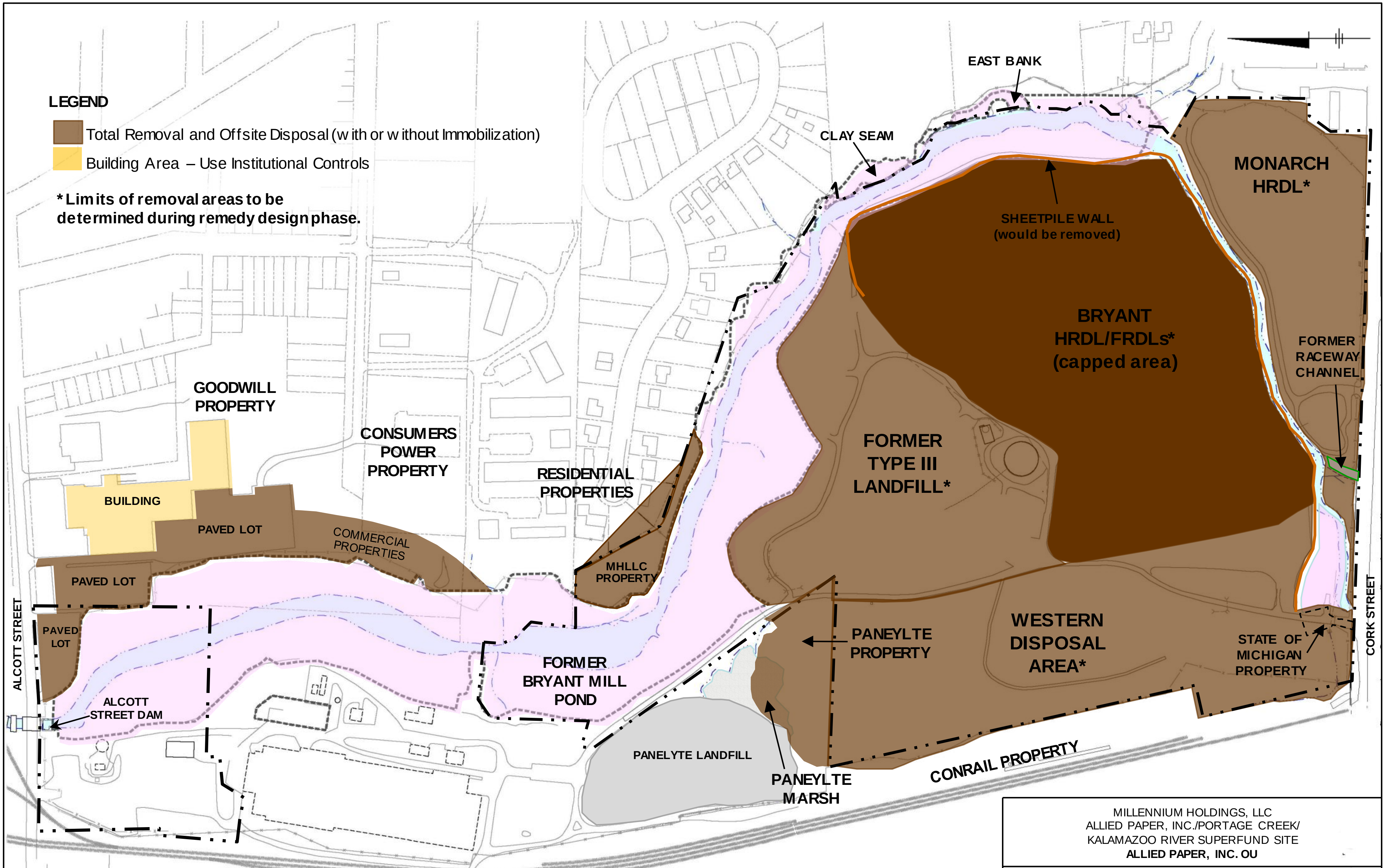
MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

ALTERNATIVE 4B
Removal and Offsite Disposal of Outlying Areas, Onsite Consolidation/Containment of Former Operational Areas beneath Impermeable Engineered Barrier

ARCADIS

FIGURE
4-7

MFE: AlliedOUFS_Sect4Figs.ppt



Edge of Water or Drainage Channel
Road/Trail
Approximate Property Line from County Tax Map
Surveyed Property Boundary
Previously Remediated Area

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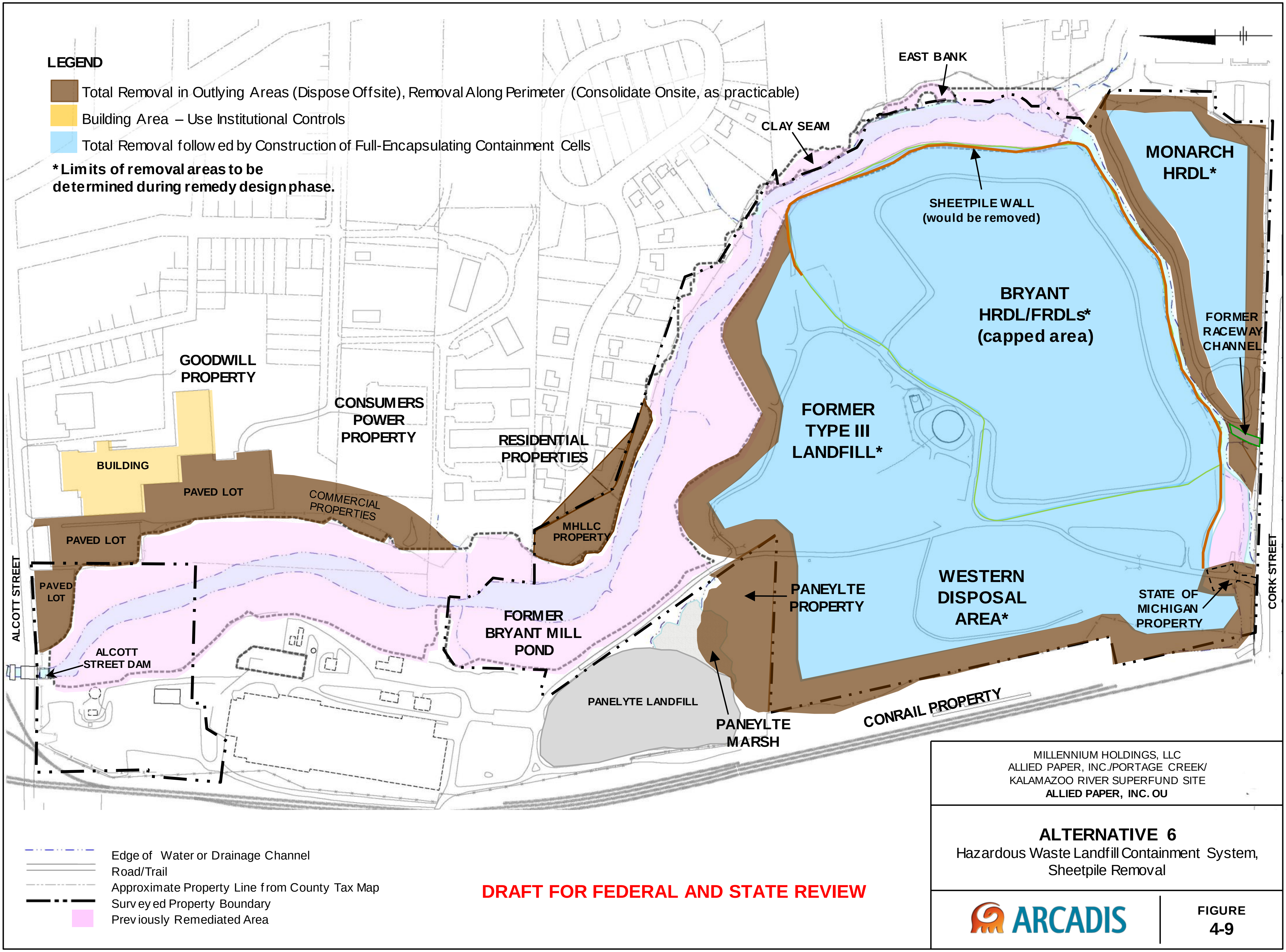
MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

ALTERNATIVE 5
Total Removal and Offsite Disposal,
Sheetpile Removal

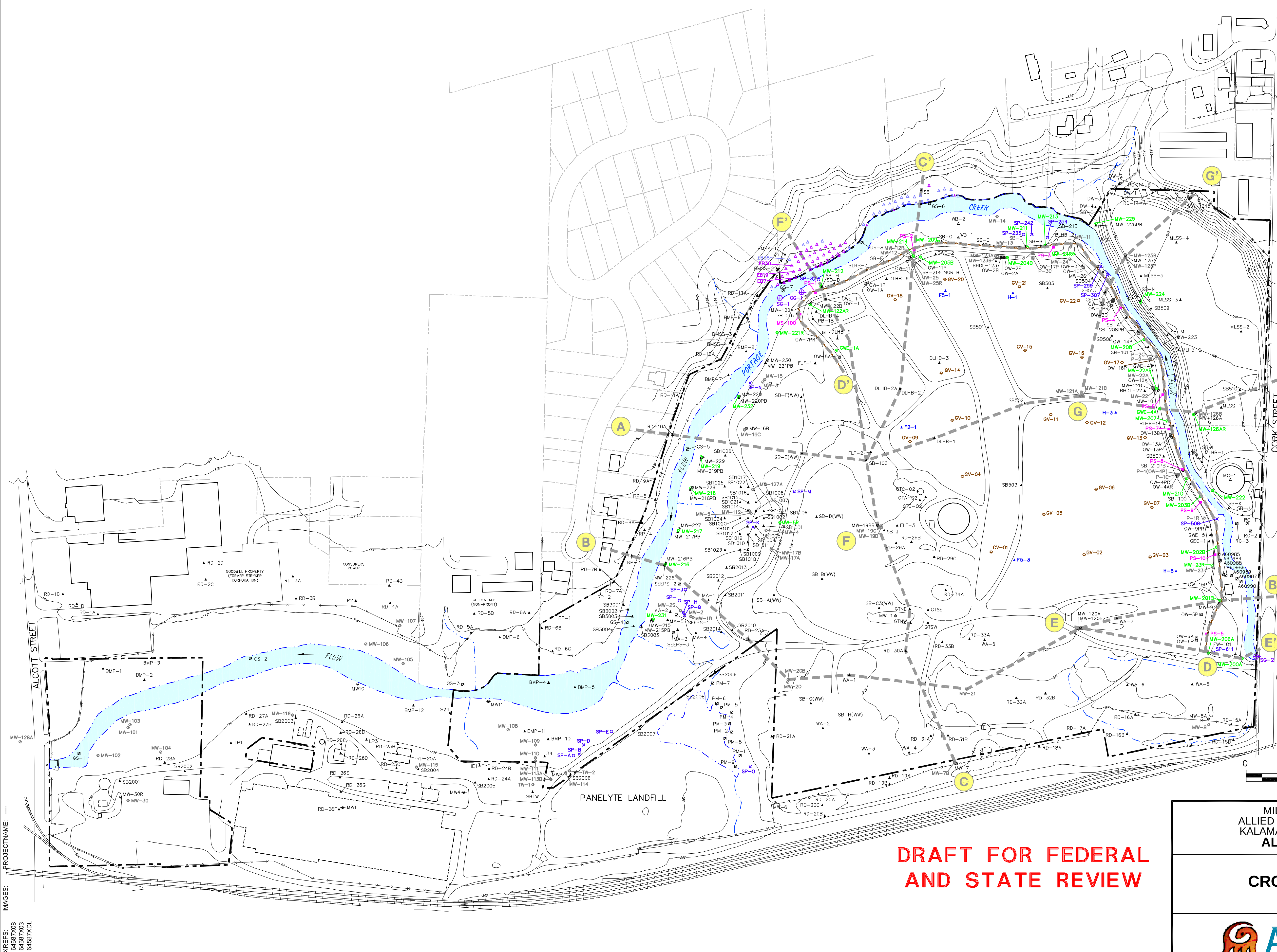
ARCADIS

FIGURE
4-8

MFE: AlliedOUFS_Sect4Figs.ppt



MFE: AlliedOUFS_Sect4Figs.ppt



LEGEND:

	EDGE OF WATER OR DRAINAGE CHANNEL
	ROAD/TRAIL
	SHEETPILE LOCATION
790	ELEVATION CONTOUR (NGVD 1929)
MW-26	SINGLE-CASED MONITORING WELL OR CLUSTER
MW-203B	DOUBLE-CASED MONITORING WELL
MW-125B	ABANDONED MONITORING WELL OR PIEZOMETER
MW1	MONITORING WELL INSTALLED BY PANELYTE
OW-12A	PIEZOMETER LOCATION
GWE-1A	RECOVERY WELL LOCATION
PS-4	EXISTING DRAINAGE SUMP
SB-100	SOIL BORING LOCATION
H-1	GEOTECHNICAL SAMPLE LOCATION
GS-5	SEDIMENT SAMPLE LOCATION
SP D	SEEP WELL LOCATION
WB-1	SURFACE GRAB SAMPLE
	BANK FACE SAMPLE (APPROXIMATE LOCATION)
EB-7	SOIL BORING LOCATION (LOCATIONS IN BLUE SURVEYED BY ATWELL-HICKS, 2001, ALL OTHERS APPROXIMATE)
SG-1	SURFACE WATER GAUGE STATION
GV-07	GAS VENT
A — A'	CROSS-SECTION LOCATION

NOTES:

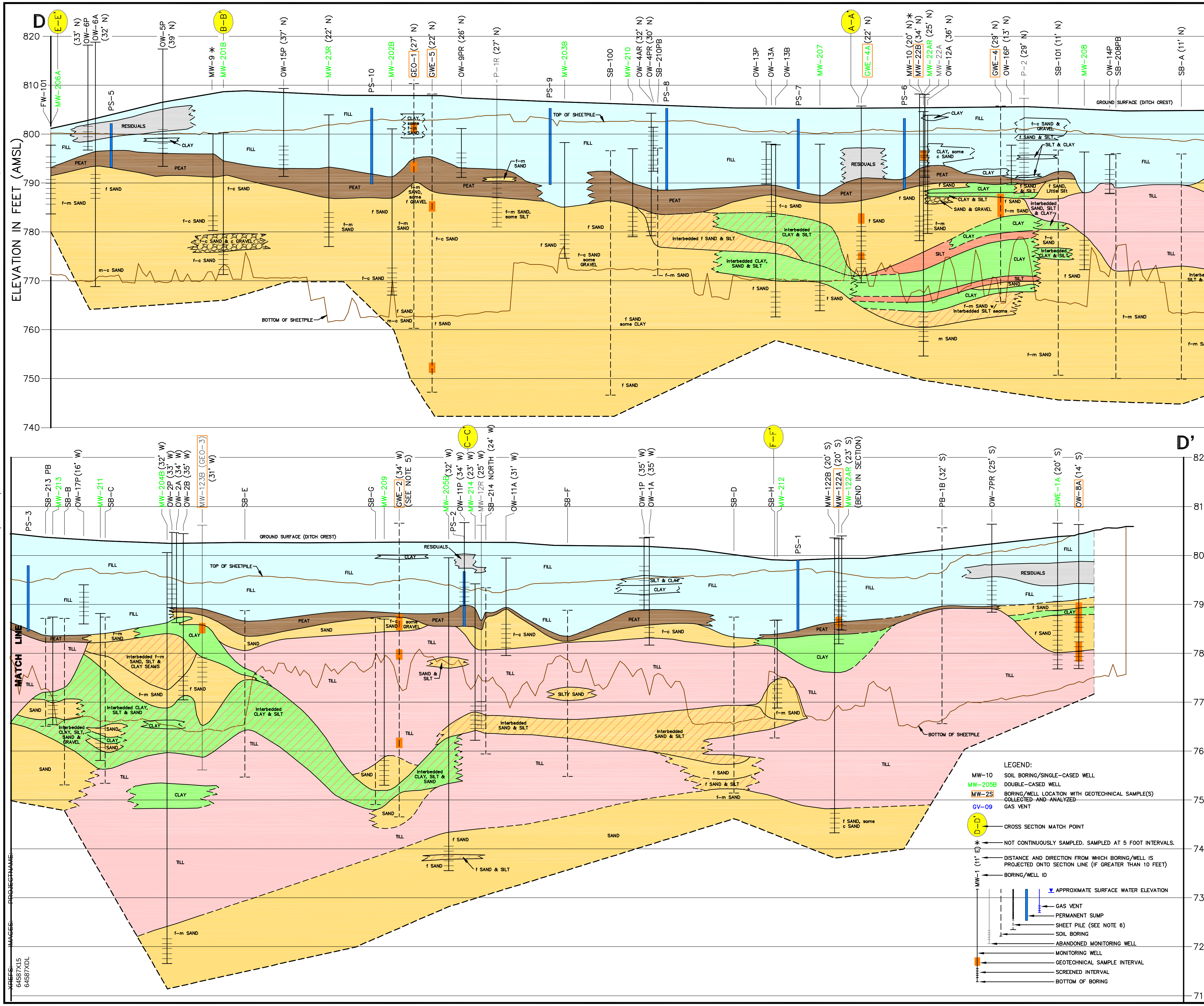
1. BASE MAP PREPARED USING: LOCKWOOD, INC. MAY 1991 AERIAL PHOTO; DIGITIZED COPIES OF PAPER TAX MAPS; AND PROPERTY OWNER INFORMATION FROM KALAMAZOOCITY.ORG WEBSITE.
2. ALLIED PROPERTY LINES ESTABLISHED USING: WADE-TRIM SURVEY (9/1999)-NORTHERN PARCEL ONLY; ATWELL HICKS, INC. SURVEY (11/2002); AND PREIN AND NEWHOF SURVEY (12/2002).
3. PORTAGE CREEK OUTLINE WITHIN THE ALLIED PROPERTY UPDATED ON 12/4/02 USING DIGITAL ORTHOGRAPHY BY AIR LAND SURVEYS, INC.(4/24/00) SCANNED FROM CDM DRAWING DETSVR/DETL007770/C: /PROJ/28963/_GIS/OU1/OU1_REPORT.APR REVISED 11/10/02.
4. PORTAGE CREEK OUTLINE NORTH OF THE ALLIED PROPERTY UPDATED ON 12/4/02 USING A CDM CREEK OUTLINE PREPARED ON 9/23/02 PROVIDED ON COMPACT DISK.
5. TOPOGRAPHIC MAPPING PRODUCED USING PHOTOGRAMETRIC METHODS BY LOCKWOOD, INC FROM AERIAL PHOTOGRAPHY FLOWN MAY 1991.
6. BASE MAP LOCATED IN MICHIGAN STATE PLANE COORDINATE SYSTEM.
7. TOPOGRAPHIC CONTOUR LINES INSIDE THE MONARCH HRDL AREA SURVEYED BY PREIN & NEWHOF SURVEYORS ON 4/03. NAVD 1929.
8. LOCATION OF GRAB SAMPLE MC-1 IN THE AREA OF THE MONARCH CLARIFIER IS BASED ON FIELD OBSERVATION.

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

CROSS-SECTION PLAN

ARCADIS

FIGURE
4-10



FILL: CONSISTS CHIEFLY OF A HETEROGENEOUS MIXTURE OF SAND AND SILT WITH VARIABLE AMOUNTS OF GRAVEL AND OCCASIONAL DISCONTINUOUS INTERVALS OF REWORKED PEAT. MAY CONTAIN TRACE AMOUNTS OF RESIDUALS.

RESIDUALS: RESIDUALS MAY CONTAIN THIN LAYERS OF SAND OR OTHER FILL.

PEAT: DEPOSITS OF POST-GLACIAL AGE CONSISTING OF PEAT OR ORGANIC-RICH SILT OR CLAY.

SAND: PREDOMINANT GRAIN SIZE OF SAND SHOWN AS FINE [f], MEDIUM [m], OR COARSE [c]. MAY CONTAIN SMALL AMOUNTS OF CLAY, SILT, OR GRAVEL.

GRAVEL: GRAVEL MAY CONTAIN SMALL AMOUNTS OF f–c SAND, SILT AND CLAY.

CLAY: CLAY MAY CONTAIN SMALL AMOUNTS OF f–c SAND AND SILT.

SILT: SILT MAY CONTAIN SMALL AMOUNTS OF f–c SAND AND CLAY.

TILL: A GENERALLY HARD DEPOSIT WITH LITTLE OR NO SORTING AND CONSISTING CHIEFLY OF f SAND, SILT, AND/OR CLAY IN VARYING PROPORTIONS, WITH LESSER AMOUNTS OF m–c SAND AND GRAVEL. MAY CONTAIN OCCASIONAL, DISCONTINUOUS LENSES OF SILT, SAND, AND/OR GRAVEL.

NOTES:

1. GEOLOGIC CONTACTS DASHED WHERE INFERRED.
2. SURFACE ELEVATIONS FROM PROPOSED TOP OF FINAL COVER PLAN (FIGURE 4) OF BBL's 1999 ENGINEERING DESIGN REPORT.
3. AMSL = ABOVE MEAN SEA LEVEL (NGVD OF 1929).
4. THIS CROSS SECTION IS ALIGNED ALONG THE SHEET PILE WALL. BORING/WELL SCHEMATICS AND ASSOCIATED SRATIGRAPHY ARE PROJECTED.
5. DUE TO THE AVAILABILITY OF DATA FROM SOIL BORINGS SB-G AND MW-209, WHICH ARE CLOSER TO THE LINE OF SECTION, DATA FROM ONLY TWO INTERVALS AT BORING GWE-2 WERE USED IN THIS CROSS SECTION: 0 TO 22 FEET AND 55 – 60 FEET BELOW LAND SURFACE.

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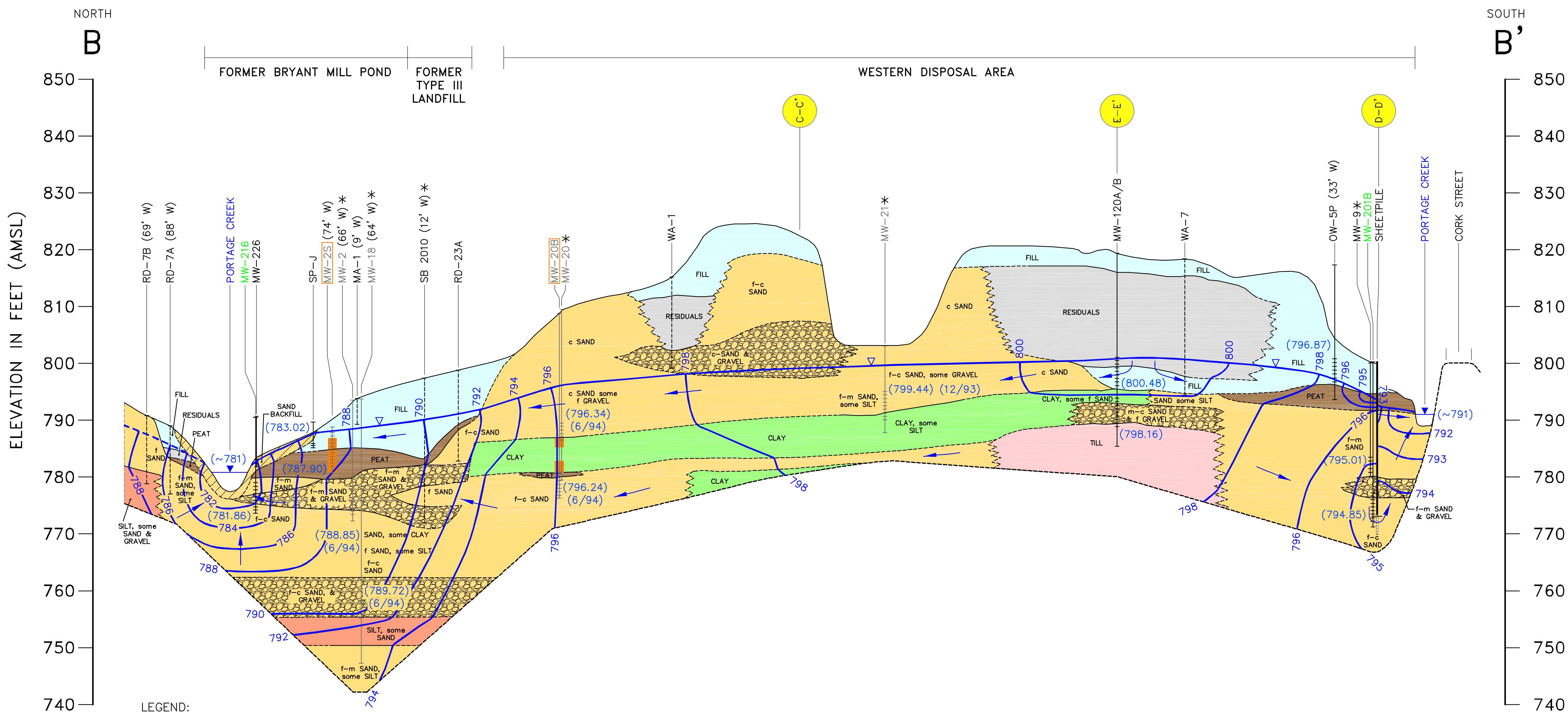
0 10' 20'
VERTICAL SCALE
0 50' 100'
HORIZONTAL SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GEOLOGIC CROSS-SECTION D-D'

ARCADIS

FIGURE
4-11



LEGEND:

- MW–10 — SOIL BORING/SINGLE–CASED WELL
- MW–205B — DOUBLE–CASED WELL
- MW–2S — BORING/WELL LOCATION WITH GEOTECHNICAL SAMPLE(S) COLLECTED AND ANALYZED
- GV–09 — GAS VENT
- D–D' — CROSS SECTION MATCH POINT
- * — NOT CONTINUOUSLY SAMPLED. SAMPLED AT 5 FOOT INTERVALS.
- (11' E) — DISTANCE AND DIRECTION FROM WHICH BORING/WELL IS PROJECTED ONTO SECTION LINE (IF GREATER THAN 10 FEET)
- MW–1 — BORING/WELL ID
- APPROXIMATE SURFACE WATER ELEVATION
- WATER TABLE 6/19/03 (DASHED WHERE INFERRED)
- GAS VENT
- PERMANENT SUMP
- SHEET PILE (SEE NOTE 6)
- SOIL BORING
- ABANDONED MONITORING WELL
- MONITORING WELL
- GEOTECHNICAL SAMPLE INTERVAL
- (796.24) — SCREENED INTERVAL AND HYDRAULIC HEAD, 6/19/03, UNLESS OTHERWISE NOTED
- BOTTOM OF BORING
- 796 — EQUIPOTENTIAL LINE (FEET, AMSL) (CONTOUR INTERVAL AS SHOWN)

FILL: CONSISTS CHIEFLY OF A HETEROGENEOUS MIXTURE OF SAND AND SILT WITH VARIABLE AMOUNTS OF GRAVEL AND OCCASIONAL DISCONTINUOUS INTERVALS OF REWORKED PEAT. MAY CONTAIN TRACE AMOUNTS OF RESIDUALS.

SAND BACKFILL: EXTENT (VERTICAL & HORIZONTAL) OF SAND BACKFILL PLACED FOLLOWING THE USEPA'S REMOVAL ACTION AT THE FORMER BRYANT MILL POND IS BASED ON A REVIEW OF THE FINAL REPORT (WESTON, 2000). TOTAL DEPTH OF EXCAVATION WAS NOT PROVIDED WITHIN THE REPORT.

RESIDUALS: RESIDUALS MAY CONTAIN THIN LAYERS OF SAND OR OTHER FILL.

PEAT: DEPOSITS OF POST–GLACIAL AGE CONSISTING OF PEAT OR ORGANIC–RICH SILT OR CLAY.

SAND: PREDOMINANT GRAIN SIZE OF SAND SHOWN AS FINE [f], MEDIUM [m], OR COARSE [c]. MAY CONTAIN SMALL AMOUNTS OF CLAY, SILT, OR GRAVEL.

GRAVEL: GRAVEL MAY CONTAIN SMALL AMOUNTS OF f–c SAND, SILT AND CLAY.

CLAY: CLAY MAY CONTAIN SMALL AMOUNTS OF f–c SAND AND SILT.

SILT: SILT MAY CONTAIN SMALL AMOUNTS OF f–c SAND AND CLAY.

TILL: A GENERALLY HARD DEPOSIT WITH LITTLE OR NO SORTING AND CONSISTING CHIEFLY OF f SAND, SILT, AND/OR CLAY IN VARYING PROPORTIONS, WITH LESSER AMOUNTS OF m–c SAND AND GRAVEL. MAY CONTAIN OCCASIONAL, DISCONTINUOUS LENSES OF SILT, SAND, AND/OR GRAVEL.

NOTES:

1. SURFACE–WATER ELEVATIONS ARE APPROXIMATE.
2. DASHED LINES BETWEEN UNITS REPRESENT INFERRED BOUNDARIES.
3. SURFACE ELEVATIONS FROM TOPOGRAPHIC MAPPING BY LOCKWOOD MAPPING, INC., AND MONITORING WELL/BORING SURVEY DATA.
4. AMSL = ABOVE MEAN SEA LEVEL (NGVD OF 1929).
5. THE DASHED PORTION OF THE SHEET PILE ILLUSTRATES THE HIGHEST AND LOWEST DRIVEN DEPTH OF THE PILING WITHIN 20 FT. OF EITHER SIDE OF THE LINE OF SECTION. THE HORIZONTAL LINE DEPICTS THE DRIVEN DEPTH OF THE SHEET PILE ALONG THE LINE OF SECTION.
6. GROUNDWATER ELEVATION FOR SP–J MEASURED ON 6/20/2003.

10' 0 10' 20'
VERTICAL SCALE

100' 0 100' 200'
HORIZONTAL SCALE

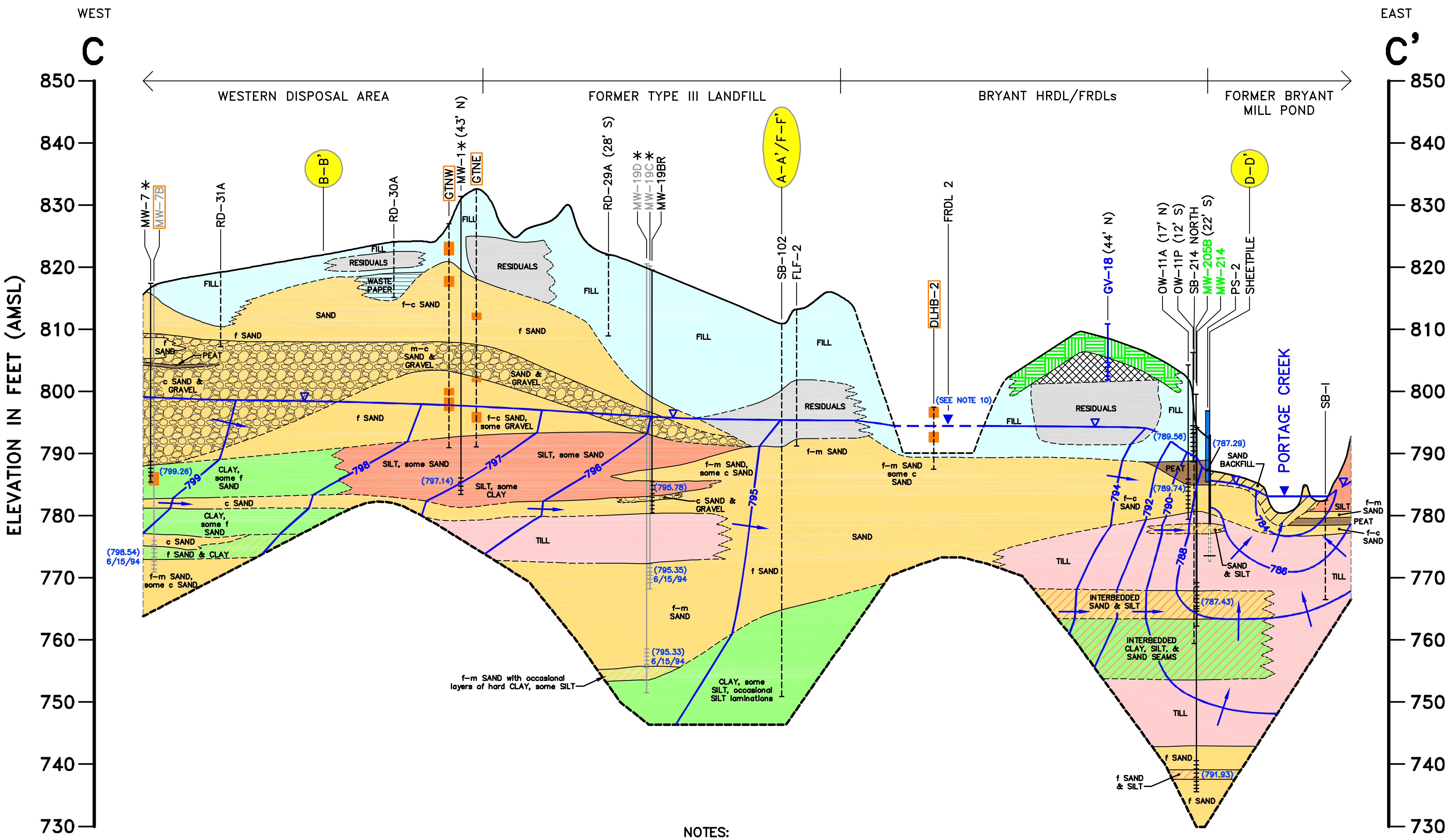
DRAFT FOR FEDERAL AND STATE REVIEW

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GEOLOGIC CROSS-SECTION B-B'
GROUNDWATER FLOW NET JUNE 19, 2003

ARCADIS

FIGURE
4-12



LEGEND:

MW-10 — SOIL BORING/SINGLE-CASED WELL

MW-205B — DOUBLE-CASED WELL

MW-2S — BORING/WELL LOCATION WITH GEOTECHNICAL SAMPLE(S) COLLECTED AND ANALYZED

GV-09 — GAS VENT

D-D' — CROSS SECTION MATCH POINT

✱ — NOT CONTINUOUSLY SAMPLED. SAMPLED AT 5 FOOT INTERVALS.

(11' E) — DISTANCE AND DIRECTION FROM WHICH BORING/WELL IS PROJECTED ONTO SECTION LINE (IF GREATER THAN 10 FEET)

MW-1 — BORING/WELL ID

APPROXIMATE SURFACE WATER ELEVATION

WATER TABLE 6/19/03 (DASHED WHERE INFERRED)

GAS VENT

PERMANENT SUMP

SHEET PILE (SEE NOTE 8)

SOIL BORING

ABANDONED MONITORING WELL

MONITORING WELL

GEOTECHNICAL SAMPLE INTERVAL

(787.29) — SCREENED INTERVAL AND HYDRAULIC HEAD, 6/19/03, UNLESS OTHERWISE NOTED

BOTTOM OF BORING

792 — EQUIPOTENTIAL LINE (FT. AMSL) (CONTOUR INTERVAL AS SHOWN)

CAP MATERIALS: SEE APPENDIX F FOR DETAILS.

BMP FILL: SEDIMENT EXCAVATED FROM THE FORMER BRYANT MILL POND AND PLACED WITHIN THE BRYANT HRDL AND FRDLs DURING THE USEPA REMOVAL ACTION.

FILL: CONSISTS CHIEFLY OF A HETEROGENEOUS MIXTURE OF SAND AND SILT WITH VARIABLE AMOUNTS OF GRAVEL AND OCCASIONAL DISCONTINUOUS INTERVALS OF REWORKED PEAT. MAY CONTAIN TRACE AMOUNTS OF RESIDUALS.

SAND BACKFILL: EXTENT (VERTICAL & HORIZONTAL) OF SAND BACKFILL PLACED FOLLOWING THE USEPA'S REMOVAL ACTION AT THE FORMER BRYANT MILL POND IS BASED ON A REVIEW OF THE FINAL REPORT (WESTON, 2000). TOTAL DEPTH OF EXCAVATION WAS NOT PROVIDED WITHIN THE REPORT.

RESIDUALS: RESIDUALS MAY CONTAIN THIN LAYERS OF SAND OR OTHER FILL.

WASTE PAPER: STACKED WASTE CARBON COPY PAPER (ONLY OBSERVED IN BORING RD-30A).

PEAT: DEPOSITS OF POST-GLACIAL AGE CONSISTING OF PEAT OR ORGANIC-RICH SILT OR CLAY.

SAND: PREDOMINANT GRAIN SIZE OF SAND SHOWN AS FINE [f], MEDIUM [m], OR COARSE [c]. MAY CONTAIN SMALL AMOUNTS OF CLAY, SILT, OR GRAVEL.

GRAVEL: GRAVEL MAY CONTAIN SMALL AMOUNTS OF f-c SAND, SILT AND CLAY.

CLAY: CLAY MAY CONTAIN SMALL AMOUNTS OF f-c SAND AND SILT.

SILT: SILT MAY CONTAIN SMALL AMOUNTS OF f-c SAND AND CLAY.

TILL: A GENERALLY HARD DEPOSIT WITH LITTLE OR NO SORTING AND CONSISTING CHIEFLY OF f SAND, SILT, AND/OR CLAY IN VARYING PROPORTIONS, WITH LESSER AMOUNTS OF m-c SAND AND GRAVEL. MAY CONTAIN OCCASIONAL, DISCONTINUOUS LENSES OF SILT, SAND, AND/OR GRAVEL.

10' 0 10' 20'
VERTICAL SCALE

100' 0 100' 200'
HORIZONTAL SCALE

NOTES:

1. SURFACE-WATER ELEVATIONS ARE APPROXIMATE.
2. DASHED LINES BETWEEN UNITS REPRESENT INFERRED BOUNDARIES.
3. SURFACE ELEVATIONS FROM TOPOGRAPHIC MAPPING BY LOCKWOOD MAPPING, INC., AND MONITORING WELL/BORING SURVEY DATA.
4. LANDFILL CAP ELEVATIONS REFLECT TOP OF INTERIM COVER SYSTEM, AS DESCRIBED IN BBL's 1999 ENGINEERING DESIGN REPORT.
5. AMSL = ABOVE MEAN SEA LEVEL (NGVD OF 1929).
6. GEOLOGY FROM MW-205B USED FROM AN ELEVATION OF 759.5 TO 735 AMSL.
7. THE DASHED PORTION OF THE SHEET PILE ILLUSTRATES THE HIGHEST AND LOWEST DRIVEN DEPTH OF THE PILING WITHIN 20 FT. OF EITHER SIDE OF THE LINE OF SECTION. THE HORIZONTAL LINE DEPICTS THE DRIVEN DEPTH OF THE SHEET PILE ALONG THE LINE OF SECTION.
8. REFRACTION ANGLES OF EQUIPOTENTIAL LINES ARE APPROXIMATE. THE FLOWNETS AS ILLUSTRATED ARE CONCEPTUAL, AND CONSISTENT WITH THE AVAILABLE DATA.
9. WATER ELEVATION FOR FRDL 2 IS A RESULT OF PUMPING; THEREFORE, WAS NOT USED FOR CONTOURING. UNDER NON-PUMPING CONDITIONS THE ELEVATIONS OF FRDLs 1 & 2 ARE SIMILAR. AN APPROXIMATE ELEVATION OF 794.5 WAS USED FOR CONTOURING.

DRAFT FOR FEDERAL AND STATE REVIEW

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GEOLOGIC CROSS-SECTION C-C' GROUNDWATER FLOWNET JUNE 19, 2003

ARCADIS

FIGURE
4-13

ARCADIS

ATTACHMENTS

ARCADIS

Attachment 1

Draft Supplemental Groundwater Investigation Report (ARCADIS 2009)

ARCADIS
Infrastructure, environment, buildings

Allied Paper, Inc./Portage Creek/ Kalamazoo River Superfund Site

Supplemental Groundwater Investigation Report

Allied Operable Unit, Kalamazoo, Michigan

October 2009

ARCADIS

DRAFT FOR FEDERAL AND STATE REVIEW

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Supplemental Groundwater Investigation Report

Allied Operable Unit, Kalamazoo, Michigan

Allied Paper, Inc./Portage Creek/ Kalamazoo River Superfund Site

Prepared for:
Millennium Holdings, LLC

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Our Ref.:
B0064587.0001.00003

Date:
October 2009

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Tables

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1. Introduction

On behalf of Millennium Holdings, LLC (MHLLC[1]), ARCADIS has completed Supplemental Groundwater Investigation activities at the Allied Operable Unit (Allied OU) of the Kalamazoo River Superfund Site to obtain additional information regarding the potential flow paths of groundwater from the Allied OU. These activities were completed at the request of and with the approval of the United States Environmental Protection Agency (USEPA). The primary goal of the supplemental work was to address concerns expressed by the City of Kalamazoo (the City) in their September 17, 2008 correspondence, titled *Interim Technical Responses to the Allied Paper Operable Unit, Kalamazoo, Michigan, Remedial Investigation Report* (City of Kalamazoo 2008a), particularly with regard to the potential for polychlorinated biphenyls (PCBs) present at the Allied OU to migrate to the City's drinking water wells. In its document, among other things, the City expressed the concern that this issue was not adequately addressed in the Remedial Investigation (RI) Report for the Allied OU, which was issued by the Michigan Department of Environmental Quality (MDEQ) in March 2008 (MDEQ 2008a). In subsequent discussions, the City also expressed concern that should there be a direct flow path for groundwater from the Allied OU to the City's Central Well Field, the public water supply might be affected by inorganic constituents that have been detected in samples of groundwater collected from certain shallow monitoring wells at the Allied OU.

To better understand the concerns of City representatives, ARCADIS and MHLLC convened a series of teleconferences and meetings, concluding with a meeting on April 14, 2009, attended by the USEPA, MDEQ, and City and community representatives. These discussions resulted in the development of the proposed scope of work, presented in the *Groundwater Evaluation and Work Plan for Supplemental Investigation* (Work Plan), dated April 28, 2009 (ARCADIS 2009). Drafts of the Work Plan were shared and discussed among key stakeholders, including the City. The Work Plan was approved by the USEPA on May 26, 2009, and field activities were subsequently implemented in late June and early July 2009. The preliminary indications of the investigation were presented to the USEPA, MDEQ, the City, and the public on July 28, 2009. This report presents the data and findings of the Supplemental Groundwater Investigation.

1.1 Purpose

The overall purpose of the Supplemental Groundwater Investigation activities described in this report was to address the City's concern that constituents present in the shallow

[1] LeMean Property Holdings Corporation (LeMean) owns the Kalamazoo River Allied site. LeMean is a wholly owned subsidiary of Millennium Holdings, LLC (MHLLC). MHLLC is directing the work at the site on behalf of LeMean.

groundwater at the Allied OU could impact the City's Central Well Field via groundwater migration.

The City's concern stems from a regional groundwater flow model prepared by the City that indicates that the limits of the 5-year time of travel zone of the Central Well Field potentially extends at depth beneath the Allied OU. The USEPA-approved RI Report (MDEQ 2008a) shows the capture of shallow groundwater by Portage Creek.

1.2 Site History

The Allied OU is one of four land-based OUs associated with the Kalamazoo River Superfund Site, and encompasses 89 acres along Portage Creek within the City of Kalamazoo, Michigan. The limits of the Allied OU are shown on Figure 1-1.

The Allied OU includes areas that were associated with operation of the former Bryant and Monarch Paper Mills. These mills were initially operated using virgin paper pulp to create paper products; however, starting in approximately the 1950s, the mills in the Kalamazoo area began to recycle waste paper. Carbonless copy paper produced between approximately 1957 and 1971 was included in the recycled waste paper, and was later found to contain PCBs. As a result, a portion of the paper-making residuals (residuals) associated with the Allied OU contain PCBs.

A series of remedial measures have been implemented at the Allied OU, the most significant of which was the excavation of approximately 146,000 cubic yards of PCB-containing residuals and soil from the Former Bryant Mill Pond area of Portage Creek. This work was completed as a time-critical removal action by the USEPA, and the excavated materials were placed within existing waste management areas of the property, west of Portage Creek. These disposal areas were subsequently capped. Additional interim response actions included:

- Installation of approximately 2,600 linear feet of sheet piling along the west bank of Portage Creek in 2001;

- Construction of a landfill cap, consistent with Michigan Act 451, Part 115 solid waste regulations;

- Installation of a groundwater recovery system to mitigate mounding of groundwater behind the sheet pile wall; and

- Excavation and onsite consolidation, within existing waste management areas that were subsequently capped, of additional residuals from the east side of Portage Creek and from the west side of the creek between the sheet pile wall and the creek.

A Feasibility Study (FS) is underway for the Allied OU that will evaluate various alternative remedies to address remaining concerns. The FS, which is scheduled to be submitted to the USEPA in October 2009, will incorporate data from the RI and the Supplemental Groundwater Investigation.

1.3 Existing Information

Over the past 16 years, an extensive series of investigations has been completed at the Allied OU and a large database has been developed. Tables of historical groundwater elevation data for the Allied OU and neighboring properties are included in Attachment A. An overview of information from the RI, and additional data collected following submittal of the document that can be drawn on to understand the hydrogeologic environment and the potential for transport of PCBs or inorganics in groundwater are presented below.

1.3.1 Hydrogeologic Setting

The unconsolidated materials and groundwater investigated at the Allied OU are within the surficial aquifer unit (MDEQ 2008a), which is subdivided into several transmissive zones that are separated locally by discontinuous confining layers. The lowermost of the transmissive zones of the surficial aquifer unit is identified in the RI Report as the “Lower Sand” (MDEQ 2008a). The groundwater and surface water elevation data collected prior to completion of the Supplemental Groundwater Investigation, as described in the RI Report, show that shallow groundwater discharges to Portage Creek. A series of groundwater flow maps prepared for the Allied OU consistently show groundwater contours that parallel the creek, indicating that groundwater flow is to the creek, with a northerly component of flow at the north end of the site in the vicinity of the dam. Monitoring well clusters, consisting of well groups with screens placed at different depths, have shown upward vertical gradients from the lower sand to the shallower geologic units and Portage Creek.

Two groundwater flow models completed for the Kalamazoo area (City of Kalamazoo 1999; U.S. Geological Survey [USGS] 2004) include horizontal “confining” units that extend beneath the Allied OU. A confining unit, or aquitard, is a geologic layer that limits or constrains the vertical movement of groundwater, and where laterally extensive, can hydraulically separate more transmissive strata. Cross-section B” to B’” (Figure 1-3), constructed from the Central Well Field through the Allied OU to the Millwood Well Field, at the location shown on Figure 1-2 shows the upper confining unit as a clayey silt, shown in green on the figure. This aquitard was not encountered during site investigations at the Allied OU because monitoring wells were not installed to the depth of the aquitard. As shown on Figure 1-3, in the area of the Central Well Field and further north toward the Kalamazoo River, one continuous unconfined sand unit is present, and the confining unit is absent. However, proceeding south, two monitoring wells south of the Central Well Field (81-10 and 81-11) indicate the presence of a thin clay unit that appears to be the northernmost extent of the confining unit (Figure 1-3). Three boring logs for wells located near the northern end of the Allied OU that were completed for environmental investigation of the neighboring Strebor property, clearly show the presence of a substantial clay unit aquitard, and the unit thickens toward the south as evidenced by the Millwood Well Field well logs. Based on the available data from supplemental information sources (MDEQ 2008b; Bay West 1991; City of Kalamazoo 1999), the continuous presence of the aquitard below the entire Allied OU can be inferred.

The presence of a continuous confining unit would limit the physical and chemical interface between the surficial aquifer and the regional aquifer in which the Central Well Field wells are installed. Further evidence indicating that groundwater from the Allied OU is not traveling toward the Central Well Field is provided by groundwater gradients. As discussed further in Section 3.3, regional data, including historical data from Strebor wells (Bay West 1991), indicate that there is an upward gradient from the regional aquifer unit to the surficial aquifer unit. The data available prior to collection of Supplemental Groundwater Investigation data suggested the presence of an aquitard between the surficial aquifer and the regional aquifer, and demonstrated the presence of upward vertical gradients. The presence of these conditions suggests that a complete migration pathway from the Allied OU to the City Central Well Field does not exist.

1.3.2 PCB Fate and Transport

Available information suggests that PCBs are not likely to impact the City's Central Well Field for the following reasons:

- PCBs are hydrophobic and do not readily dissolve in water, preferring to adhere to soil or other solids (USEPA 1979; MDEQ 2008a, 2008b). To the limited extent that PCBs do enter groundwater, travel pathways would be dictated by groundwater gradients.

- Groundwater samples from the Allied OU generally do not contain PCB concentrations above MDEQ criteria or the USEPA's Preliminary Remediation Goals (CH2M Hill 2009). Exceptions are a few instances where a well was screened in close proximity to a layer of PCB-containing residuals. Figure 1-4 illustrates the results of PCB analysis of groundwater samples collected in 2002 and 2003, following implementation of the remedial measures completed to date. As shown, out of a total of 53 locations sampled, MDEQ's Groundwater/Surface Water Interface (GSI) criterion for PCBs of 0.2 micrograms per liter (ug/L) was exceeded at three shallow monitoring points screened in direct contact with residuals. The Residential Drinking Water (RDW) criterion of 0.5 ug/L was exceeded in one split sample collected by the MDEQ (MDEQ 2004, 2008a). PCBs were detected at a concentration of 0.549 ug/L at MW-8A on October 29, 2002. The primary and duplicate samples collected by MHLLC on the same date contained PCBs at concentrations of 0.33 and 0.28 ug/L, respectively; below the RDW criterion (MDEQ 2008a).

- Prior work at the Allied OU (MDEQ 2008a) suggested that shallow groundwater discharges to Portage Creek.

- Water samples collected between October 2005 and the present from the influent of the Allied OU leachate collection system contained a detectable concentration of PCBs below both the GSI and RDW criteria on one date. A total of 38 samples were collected between October 2005 and the present, consisting of monthly samples from March 2006 through December 2008, and biannual samples from December 2008 to the present. Of these, all but one sample (97 percent) were non-detect for PCBs. The single detection was reported at the detection limit (0.1 ug/L), which is below the MDEQ's GSI criterion for PCBs. All of these samples are from water in direct contact with PCB-containing residuals, again confirming the hydrophobic nature of PCBs.

1.3.3 Inorganic Constituents in Groundwater

The RI Report indicates that certain naturally-occurring inorganic constituents (most notably iron, manganese, and arsenic) have been detected in certain shallow groundwater samples at the Allied OU at concentrations that slightly exceed (i.e., are within the same order of magnitude of) MDEQ groundwater criteria. The City of Kalamazoo has expressed concern that should there be a direct flow path for groundwater from the Allied OU to the City's Central Well Field, the public water supply might be affected by these inorganic constituents. As discussed in the following sections, the additional studies conducted for the Supplemental Groundwater Investigation were also useful in consideration of inorganic constituents in groundwater.

2. Scope of Investigation

ARCADIS evaluated various approaches and data needs required to assess the potential for a complete groundwater pathway from the Allied OU to the City's Central Well Field. Establishing an expanded hydrogeologic conceptual model, by providing additional measurement of hydraulic gradients in the vertical and horizontal directions, was selected as a direct method to assess whether the potential exists for PCBs present at the Allied OU to impact the City's Central Well Field. The primary hypotheses, which the investigation was designed to verify or disprove, are that shallow groundwater at the Allied OU discharges to Portage Creek, and that a hydraulic head differential across the low-permeability zone that underlies the Allied OU creates an upward vertical gradient, precluding potential flow to the City's Central Well Field. Synoptic measurement of water levels at available locations within and beyond the Allied OU in the direction of the City's Central Well Field was selected as the most direct and efficient way to test this hypothesis. The use of pressure transducers to collect near-continuous measurements at selected monitoring locations was considered to obtain information regarding temporal changes in groundwater flow conditions; however, due to the large amount of historical groundwater elevation data available (see Attachment A) and with the concurrence of USEPA, this method was determined to be unnecessary. Pressure transducers would have been considered in follow-up activity if the initial work suggested the need.

2.1 Identification of Potential Groundwater and Surface Water Elevation Monitoring Points

During the development of the scope of investigation for this work effort, nearby properties that have been the subject of environmental investigation were identified. The purpose of this activity was to identify existing monitoring wells near the Allied OU that could potentially provide an expanded array of groundwater monitoring points and allow for better characterization of groundwater flow patterns north and west of the Allied OU, toward the City's Central Well Field. Three properties were identified: Panelyte, Strebor, and Performance Paper. Figure 2-1 shows the locations of these neighboring properties relative to the Allied OU. Monitoring wells on each of these properties were used to obtain groundwater elevation data to provide a distribution of data points extending beyond the limits of the Allied OU.

The Strebor property is located west of the northern part of the Allied OU, and monitoring wells are present at and surrounding that property due to past environmental investigations. An active groundwater pump and treat system is also present at the Strebor property. The Panelyte property is located north of the Western Disposal Area at the Allied OU, and west of Portage Creek. Performance Paper is located north of Alcott Street, on both sides of Portage

Creek, and contains a well network previously installed during environmental investigations. Tables 2-1 and 2-2 identify the monitoring points identified for field measurement.

Of the wells identified for inclusion, three deep monitoring wells installed by Strebor that extend into the deep regional aquifer unit are of particular interest. These wells, MW-37, MW-39, and MW-40, are ideally located north and west of the Allied OU (see Figure 2-2) and each well is paired with a second well screened in the shallower, surficial aquifer unit. By comparing the relative hydraulic heads at these well cluster locations, the vertical gradient between the surficial aquifer unit that is proximal to the Allied OU residuals and the deep regional aquifer unit that is used as a drinking water source for the City, can be obtained. The remaining wells (Figure 2-2) monitored at the Allied OU, Panelyte, and Performance Paper properties are screened at various depths within the surficial aquifer unit. Additional well installations were considered but were not deemed necessary after locating appropriately positioned offsite wells. Figure 2-3 illustrates the relationship of the various monitoring well depths relative to each other and to the surficial and regional aquifer units. These units were described by the MDEQ (MDEQ 2008b) based on a review of the Groundwater Flow Model and Capture Zone Delineations prepared by the City of Kalamazoo (City of Kalamazoo 1999).

2.2 Survey Activities

To ensure that the water levels collected are referenced to a common survey datum, all of the offsite wells were surveyed between June 25 and 29, 2009 by licensed surveyors, Prein Newhof of Kalamazoo, Michigan. The top of inner casing elevations were recorded to the nearest 0.01 foot, and the ground surface elevations were established to the nearest 0.1 foot. Additional surface water level measurement locations were established at the locations shown on Figure 2-2 to provide further control on the relationship between surface water and groundwater elevations. The survey elevations are included in Tables 2-3 and 2-4.

2.3 Water Level Measurements

On June 25 and 26, 2009, water level measurements were collected at 123 monitoring wells, six staff gauge locations along Portage Creek, and one staff gauge in an area of standing water located in the southwestern part of the Allied OU. During the June 25 and 26 event, a groundwater extraction system was actively pumping at the Strebor property. A second round of measurements for a subset of 23 wells located in the vicinity of the Strebor property was conducted on July 2, 2009 during a period of shut down of the Strebor groundwater recovery system. All measurements were made using a weighted electronic water level probe per standard practices commonly accepted by USEPA and MDEQ. The collected data are summarized in Tables 2-3 and 2-4.

2.3.1 Groundwater Elevation Measurement Locations

The locations of the water level measurements are shown on Figure 2-2. All measurements were made by ARCADIS personnel, with the exception of measurements made at the Strebor wells, where as a condition of property access, Strebor's consultants collected the water level measurements under the observation of ARCADIS personnel.

2.3.2 Surface Water Elevation Measurement Locations

Due to the key role of Portage Creek in the behavior of groundwater in the study area, surface water elevation measurements were collected at the existing staff gauges and additional measurement points on existing bridge and dam abutments. In total, six points along the creek were measured. In addition, a temporary measurement point was established in a small area of standing water in the southwestern part of the Allied OU.

2.4 City of Kalamazoo Production Well Data

As part of the Supplemental Groundwater Investigation, ARCADIS also reviewed sample analytical data provided by the City for its water supply system monitoring program. The City's monitoring program has not identified PCBs in samples of groundwater collected from the Central Well Field. In 2008, samples were analyzed with analytical equipment capable of achieving detection levels well below the threshold achievable by USEPA standard methodology (USEPA 8082). Samples collected from 11 City wells in Well Fields #1 and #3 were reported to have no detections of PCBs at a detection level of 50 parts per trillion (Table 2-5), as reported in tables provided by the City of Kalamazoo via electronic mail (City of Kalamazoo 2008b). This provides direct evidence that a complete pathway does not exist for PCBs to migrate from the Allied OU to the City Central Well Field.

ARCADIS also reviewed the City's groundwater modeling results, which indicate that the Allied OU lies within a 5-year time of travel to the City's Central Well Field. PCB-containing residuals lay in an uncontrolled state for approximately 50 years subject to precipitation and natural processes, prior to the implementation of remedial actions. Given this 50-year time period, the absence of PCBs at the Central Well Field strongly suggests that a migration pathway does not exist from the Allied OU to the City's wells. Any further controls and remedial measures completed at the Allied OU following completion of the FS will further reduce any potential for migration offsite.

3. Investigation Results

Field data collection resulted in a substantial set of groundwater and surface water elevation data extending northward and westward from the Allied OU, in the direction of the City's Central Well Field. A total of 123 groundwater elevation measurements were collected; 75 from Allied OU monitoring wells and 48 from offsite locations. Surface water elevation measurements were collected at six locations along Portage Creek, and the elevation of standing water in the southwestern part of the Allied OU was also measured. The majority of the data allow for detailed characterization of the shallow surficial aquifer unit, and three monitoring well clusters provide data regarding the potential for vertical interaction between the surficial and regional aquifers in the vicinity of the Allied OU. The evaluation of the collected data is discussed in the following sections.

3.1 Groundwater Flow in the Surficial Aquifer Unit

A water table groundwater contour map, developed using the data collected on June 25 and 26, 2009, is shown on Figure 3-1. Portage Creek appears to be the primary influence on the configuration of the water table surface within the OU. In the main disposal area of the Allied OU, shallow groundwater discharges radially to Portage Creek. North of Alcott Street, the influence of Portage Creek as a location of groundwater discharge appears to be mitigated to some degree by the presence of a concrete liner, which extends from Alcott Street northward to south of Reed Avenue. In this area, shallow groundwater is influenced, although not completely captured, by the creek. There is a northerly (i.e., downstream) component of groundwater flow in this area.

Figure 3-2 shows the water table groundwater contour map with an overlay showing the approximate extent of residuals from the RI Report (MDEQ 2008a). The figure illustrates capture by Portage Creek of the shallow groundwater that could potentially be impacted by residuals at the Allied OU.

The subsurface investigation activities completed at the Allied OU, as described in the RI Report and illustrated by flow nets constructed along several cross-sections (MDEQ 2008a), have demonstrated the significant influence of vertical gradients on groundwater flow, and the potential for flow, between the various flow zones within the surficial aquifer unit. For this reason, and due to the fact that the well screen intervals of the monitored wells tend to be shallow, groundwater contour figures were not constructed at depth. Instead, the water table contour maps described above were constructed using data from wells that are screened at or near the water table surface and therefore provide comparable data points. To evaluate flow patterns at greater depth, vertical gradients were assessed, as described in Section 3.3.

Monitoring well screen depth information relative to the water table was reviewed to select data points to provide data representative of the shallow groundwater surface. The data points used to generate the water table contour figure are identified in Table 2-3.

Strebor operates several shallow groundwater recovery wells at the adjacent property northwest of the Allied OU disposal units, and to evaluate the degree of influence the pumping wells have on groundwater flow in this area, a subset of wells in this portion of the study area was gauged on July 2, 2009, following shut down of the pumping wells on July 1, 2009 for maintenance. As shown by a comparison of the central portion of Figure 3-1 (groundwater flow during operation of the Strebor wells) and Figure 3-3 (groundwater flow when the recovery system is not operating), the impact of the pumping wells on the pattern of groundwater flow is minimal. Drawdowns of 0.84 and 0.86 feet, respectively, were observed at Strebor wells MW-2 (located at the northern end of the Panelyte property) and MW-21 (located west of the Strebor property and the railroad tracks) (Figure 3-3).

The surface water elevation measurement made at the Reed Avenue bridge over Portage Creek (SG-6) was unexpectedly high, at an elevation of 763.41 feet above mean sea level (amsl). A groundwater elevation of 761.59 feet amsl was measured at the nearest shallow monitoring well, MW-14, located approximately 200 feet south on the Performance Paper property. This difference in hydraulic head suggests that surface water could locally be discharging to groundwater in this area. However, due to the distance of this area from the Allied OU (over 1400 feet from the northernmost extent of the residuals), this flow condition, if present, would not change the interpreted groundwater flow patterns at the portion of the Allied OU identified with residuals.

The data collected during this monitoring event were found to correspond well with the data presented in the RI Report, and further illustrate that pumping activities associated with the neighboring Strebor property do not change the pattern of groundwater flow within the surficial aquifer in the area. The collection of additional time series water level data was not deemed necessary due to the strength and consistency of the data.

3.2 Groundwater Flow in the Regional Aquifer Unit

Based on the groundwater modeling efforts completed by the USGS and the City (USGS 2004; City of Kalamazoo 1999), flow in the regional aquifer unit approximately 50 to 80 feet below the ground surface is to the north, toward the Kalamazoo River. Three Strebor monitoring wells included in the groundwater investigation are screened in the regional aquifer unit. The water levels measured in the three wells were above the top of the aquitard that separates the surficial and regional aquifers, indicating confined conditions in this lower zone. Due to the upward pressure exerted by the groundwater present in the regional aquifer, the downward flow of groundwater from the surficial aquifer monitored at the Allied OU to the deeper regional aquifer is highly improbable.

3.3 Vertical Flow Gradients

Two flow nets have been constructed using the June 2009 data at the locations shown on Figure 3-4. These figures depict groundwater flow in the vertical as well as the horizontal direction. The flow nets shown on Figures 3-5 and 3-6 illustrate downward gradients in the shallow fill areas (recharge areas) of the Allied OU at a distance from Portage Creek, primarily lateral flow moving toward the creek, and upward flow as the groundwater discharges to surface water.

Water elevation versus time plots for clustered wells screened at different depths were developed to assess the variation over time in vertical flow potentials between various monitored zones at specific locations. From the data collected during this groundwater investigation, three monitoring well clusters on the Allied OU property and three Strebor monitoring well clusters were selected to be depicted graphically. Figure 3-7 shows the location of the well clusters. The selection of these wells was based on spatial distribution, availability of data, and the unit of interest to be assessed.

For the Allied OU well clusters, historical data from 2006 through the present have been added to the graphs to show variations over time. Figure 3-8 illustrates data for the MW-122AR, MW-122A, MW-122B, and MW-212 monitoring well cluster. The monitoring wells in this cluster are screened at various depths within the surficial aquifer. Portage Creek water level elevations are also shown for comparison. This graph illustrates that the highest groundwater levels are observed in the upper sand, and shows a downward flow potential from the upper sand to the intermediate sand. Most importantly, the graph shows an upward gradient of approximately 0.10 feet from the lower sand unit to the intermediate sand unit. Discharge from this zone is to Portage Creek, present at the lowest elevation potential.

The graph shown on Figure 3-9 for the MW-204B, OW-2B, OW-2P, OW-2A shows a similar pattern of flow with discharge to Portage Creek at the lowest elevation; however, in this instance, the highest measured water level is in monitoring well MW-204B, which is screened in the lower sand unit of the surficial aquifer unit, indicating a strong upward gradient of approximately 0.27 feet from the lower sand unit to the upper sand unit that discharges to Portage Creek.

The third graph of data, shown on Figure 3-10, depicts data for the MW-22B, MW-10, MW-22AR, and OW-12A monitoring well cluster. In this instance, the elevation of Portage Creek is higher than the majority of measured groundwater elevations, potentially suggesting flow from or below the creek. However, this well cluster is located within approximately 25 feet of the groundwater extraction system behind the sheet pile wall. Note that the shallower wells (MW-10, MW-22AR, and OW-12A), screened in closest proximity to the recovery well points, show the most pronounced drawdown due to the influence of the groundwater removal. Importantly, the deepest well (MW-22B) generally has the highest water level, indicating an upward gradient at this location. One inconsistent measurement, collected in December 2008 at monitoring well MW-22B, shows the opposite condition; however, this data point is an anomalous outlier, varying by 3.6 feet from the average of the elevations measured from 2006 through the present at that well.

The City expressed concern that monitoring well MW-122B might be installed in the regional aquifer that is used by the City's Central Well Field, and that a downward flow gradient – as historically measured at this location relative to the shallow sand of the surficial aquifer – might direct flow of groundwater from the Allied OU to the regional aquifer. However, as shown on Figure 2-3, the screen for this well is clearly within the surficial aquifer, and well above the aquitards that separate the surficial aquifer from the lower regional aquifer. Therefore, this well will not direct flow to the regional aquifer used by the City's Central Well Field.

The City also communicated concerns that recent groundwater elevation measurements at shallow monitoring wells MW-122A and MW-122AR are conspicuously lower than measurements made historically (e.g., 2000), and that the head difference between these shallow wells and monitoring well MW-122B, screened in the lower sand unit of the surficial aquifer, is reduced from over 3 feet to a fraction of a foot. They observed that water elevation measurements at this well cluster (along with MW-122B) currently show an upward gradient where historically there was a downward gradient between the upper and lower sand units of the surficial aquifer at this location.

The differences in groundwater elevations and gradients between now and 2000 are due to this area having been covered with an impermeable cap in 2004. The MW-122-series well cluster is located in the berm immediately adjacent to Former Residuals Dewatering Lagoon (FRDL) #1, which currently and historically has been the location to which surface water runoff drains within the 22-acre Bryant HRDL/FRDLs disposal area. However, in 2000 this lagoon was unlined and any accumulated water was free to drain into the adjacent sandy berm and the shallow groundwater system, raising groundwater elevations in the immediate vicinity. In 2004, this lagoon was double-lined with an impermeable cap designed in accordance with Michigan Act 451 Part 115 solid waste regulations. As a result, surface water runoff that collects in this area is prevented from entering the groundwater system, and is discharged directly to Portage Creek. Consequently, groundwater elevations at MW-122A and MW-122AR have dropped. Note that PCBs were not detected in any groundwater samples collected from MW-122B for the RI, and inorganics were detected only at levels below MDEQ groundwater criteria, providing additional empirical evidence that groundwater does not flow downward at this location.

The monitoring well clusters at the Strebor property provide important information, as each of the three well clusters includes one well screened in the surficial aquifer unit and a second well screened in the regional aquifer unit, providing data regarding the potential for flow between the two units. Figure 3-11 illustrates the relative groundwater elevations in all three of the Strebor well clusters. At each of the three well cluster locations, there is a strong upward gradient between the regional aquifer unit and the surficial aquifer unit. For the MW-40/MW-30 well cluster, quarterly data are available for a period of 3 years, and the gradient remains consistently upward. As mentioned previously, all of the deep Strebor wells demonstrate confined conditions and one of the monitoring wells, MW-39, exhibits flowing artesian conditions. A pressure gauge was installed at the well head of MW-39 to allow for conversion of the measured pounds per square inch to feet of water. These data illustrate hydraulic disconnection between the surficial aquifer unit and the regional aquifer unit.

The results of the analysis of groundwater flow patterns, directions and gradients clearly support the RI Report conclusion that shallow groundwater at the Allied OU discharges to Portage Creek, and no additional data were obtained that suggest that there is a pathway to the regional aquifer used for the City Central Well Field. With this understanding, no further analysis was deemed necessary with respect to the distribution of inorganic constituents in onsite or offsite groundwater.

3.4 Refined Conceptual Site Model

The data collected during this investigation strongly support the Conceptual Site Model identified in the RI Report and provide a basis for a refined understanding of groundwater flow at the Allied OU and local environs. The groundwater elevation data acquired for the Supplemental Groundwater Study reflect current conditions at the Allied OU with the impermeable cap over the Bryant HRDL/FRDLs extended over the settling basin (FRDL #1), and therefore update the groundwater data, flow maps, and flow net information presented in the RI Report (MDEQ 2008). The updated data confirm that shallow groundwater within the surficial aquifer unit flows toward and discharges to Portage Creek, and that pumping at the Allied OU from behind the sheet pile has a mild influence on this flow pattern. North of Alcott

Street, the impact of the concrete-lined segment of the creek appears to mitigate the degree of capture of the shallow groundwater by the creek, and a northerly flow component is present. However, as indicated by MDEQ studies on the Performance Paper property (Malcolm Pirnie, Inc. 2004) and as shown clearly on Figure 3-2, PCB-containing residuals are not present in groundwater in this area. Overlaying the potential extent of PCBs or residuals with the groundwater flow map illustrates that Portage Creek serves as a discharge point for potentially impacted groundwater associated with the residuals at the Allied OU.

Similar to observations at the Allied OU, pumping directly from the surficial aquifer at the neighboring Strebor property has also been shown to result in minimal changes to the water table surface, and does not change the pattern of groundwater flow in the area.

The regional aquifer unit exists under confined conditions below the Allied OU, and a substantial upward gradient is present. An upward pressure gradient of 0.1 to 0.2 feet/feet exists between the regional aquifer at depth and the surficial aquifer monitored at the Allied OU mitigates the potential for the downward migration of groundwater from the surficial aquifer unit to the regional aquifer unit. The presence of confined conditions also minimizes the influence of pumping at the Central Well Field on the surficial aquifer at the Allied OU. In order to influence water levels in the surficial aquifer at the Allied OU, the upward gradient observed between the lower regional aquifer and the shallow surficial aquifer would have to be reversed. The hydraulic condition (e.g., excessive pumping) that would be required to reverse an upward gradient of 0.1 to 0.2 feet/feet between the regional and surficial aquifers over a distance of more than 2000 feet between the City's Central Well Field and the Allied OU is judged to be extremely unlikely. Differential effects of precipitation on recharging the regional and surficial aquifer systems are expected to be minimal.

3.5 Study Limitations

Although a robust data set exists for the surficial aquifer system, a limited number of wells were used to evaluate groundwater flow paths and gradients associated with the regional aquifer. If the information from these well provided ambiguous results, there might be reason to conduct further investigation into the regional aquifer conditions. However, the consistent observation of considerable upward gradients demonstrated by the well clusters in the surficial and regional aquifers over an extended period of time suggest that these conditions are likely to be laterally extensive, and representative of conditions over the long term, suggesting that no additional information is needed.

4. Findings

The Supplemental Groundwater Investigation, together with prior data, provides a basis to conclude that a groundwater pathway is not present from the Allied OU to the City Central Well Field. The key findings are summarized below, followed by a discussion of other relevant information that collectively reduce any remaining uncertainty in this conclusion.

- Groundwater table contour maps constructed for the water table show that gradients in the shallow aquifer are directed toward Portage Creek and are in an easterly, onsite direction along the western boundary of the Allied OU, with a northerly component of flow at the north end of the site near the dam (see Figure 3-1).

- The groundwater contour maps together with vertical flow nets (See Figures 3-1, and 3-3 through 3-6) indicate that Portage Creek is the discharge point for shallow groundwater at the Allied OU.

- Vertical gradients measured at three monitoring well clusters at the Allied OU screened at different depth intervals within the surficial aquifer show strong upward gradients relative to Portage Creek, and strong upward gradients from the lower sand to the shallow intermediate sand unit within the surficial aquifer. Monitoring wells at the Allied OU do not extend into the regional aquifer present at depth.

- Data for three shallow and deep well pairs previously installed by Strebor provide groundwater elevation data for both the surficial aquifer and the deeper regional aquifer, and indicate a strong upward gradient (i.e., upward flow potential) from the regional aquifer to the surficial aquifer.

These findings indicate that a groundwater flow pathway for PCBs and inorganics at the Allied OU to the City's Central Well Field is not present because: a) shallow groundwater flows to the east toward Portage Creek and not in a northwesterly offsite direction, and b) the flow potential between the deeper regional aquifer and the shallower surface aquifer is directed upward. If there is flow between these two units at the Allied OU, the available data indicate it would be upward into the shallow aquifer, with subsequent discharge to Portage Creek.

Although these findings demonstrate that the local hydrogeology indicates that groundwater at the Allied OU does not pose a threat to the City's Central Well Field, further confidence in this conclusion is lent through a review of PCB fate and transport considerations and other available information, as summarized below.

- PCBs are hydrophobic (meaning they do not readily dissolve in water and preferentially attach to soil particles) and as a result, are typically present in only very low concentrations in groundwater, especially groundwater not in immediate contact with PCB-containing materials. As a result, PCBs are not typically detected in any significant quantity in wells that are screened outside of the limits of PCB-containing residuals.

- Generally speaking, PCBs have not been observed in groundwater at levels above criteria away from the Allied OU, and detections above MDEQ criteria are observed only in the immediate vicinity of or in contact with residuals.

- The low hydraulic conductivity of residuals is also an important factor in the limited mobility of PCBs. Groundwater does not readily pass through these clay-like materials.

- The groundwater collection and treatment system currently operating at the Allied OU collects groundwater from the downgradient perimeter of the Bryant HRDL/FRDLs area. Of 38 samples of the influent to the treatment system that were collected over the period from March 2006 to present, only one sample contained a detectable concentration of PCBs. The detection was reported at the detection limit of 0.1 ug/L, which is below MDEQ's GSI criterion. No PCBs were detected in the other 37 (97 percent of samples).

- Two groundwater flow models completed for the Kalamazoo area (City of Kalamazoo 1999; USGS 2004) identify and simulate horizontal "confining" units that extend beneath the Allied OU. The confining unit that separates the surficial aquifer system monitored at the Allied OU and the regional aquifer system tapped by the City Central Well Field was encountered in the vicinity of the northern portion of the Allied OU in monitoring wells installed at the neighboring Strebor property. This confining layer is partially responsible for the upward pressure of the deeper regional aquifer into the overlying surficial aquifer, and its presence tends to limit communication of groundwater between these two aquifers.

- Routine monitoring data collected by the City of Kalamazoo from the Central Well Field show that PCBs have not been detected. Recent tests using lower detection limits confirm historical findings that PCBs are not present. Conditions at the Allied OU are not conducive to migration of groundwater from the Allied OU toward the City Central Well Field, and it is reasonable to conclude that they do not pose a threat to the City's well supply.

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Tables

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Well/ Piezometer	Date Installed	Aquifer Unit	Total Depth of Monitoring Well (feet bgs)	Top of Casing Elevation (feet AMSL)	Ground Surface Elevation (feet AMSL)	Elevation of Bottom of Screen (feet AMSL)	Elevation of Top of Screen (feet AMSL)	Elevation of Mid Point of Screen (feet AMSL)	Elevation of Top of Filter Pack (feet AMSL)	Elevation of Top of Bentonite (feet AMSL)	Hydrostratigraphic Unit Screened Within Surficial Aquifer Unit (Units as Defined in RI)
FW-101	6/10/2002	Surficial	5.0	800.36	797.3	793.1	795.3	794.2	796.3	797.3	Upper Sand
GWE-1	2/10/2000	Surficial	25.5	803.21	802.7	782.0	791.8	786.9	794.8	796.8	Upper Sand/Peat/Upper Aquitard
GWE-1A	5/4/2000	Surficial	35.0	806.07	806.6	776.8	791.7	784.2	792.8	795.6	Upper Sand/Upper Aquitard
GWE-1P	2/10/2000	Surficial	NA	803.03	NA	NA	NA	NA	NA	NA	NA
GWE-4A	6/20/2000	Surficial	34.4	805.27	805.7	771.3	781.2	776.3	784.2	801.7	Upper Sand
MW-5R	3/26/1998	Surficial	26.1	811.87	810.1	783.6	789.6	786.6	789.6	792.1	Peat/Upper Sand
MW-6	11/16/1985	Surficial	25.0	812.70	810.7	785.7	788.7	787.2	790.7	809.7	Upper Sand
MW-7	11/16/1985	Surficial	31.0	818.94	817.4	786.4	789.4	787.9	791.4	816.4	Upper Sand
MW-8A	8/10/1993	Surficial	18.0	810.74	809.0	791.0	796.0	793.5	796.0	799.0	Peat/Upper Sand/Upper Aquitard
MW-22AR	4/1/1998	Surficial	16.5	805.79	807.5	791.0	796.0	793.5	796.5	798.5	Upper Sand/Peat
MW-22B	8/11/1993	Surficial	48.0	809.25	804.6	757.6	762.6	760.1	764.6	767.6	Intermediate/Lower Sand[2]
MW-23R	10/19/2000	Surficial	25.0	809.33	804.0	779.0	784.0	781.5	786.0	793.0	Sand[3]
MW-24R	3/27/1998	Surficial	24.0	803.37	806.6	782.6	787.6	785.1	788.6	791.1	Upper Sand/Upper Aquitard
MW-26	8/25/1989	Surficial	9.0	792.10	790.0	781.0	784.0	782.5	784.0	789.0	Upper Sand
MW-120A	7/28/1993	Surficial	23.5	822.21	819.6	796.1	801.1	798.6	801.4	804.6	Residuals/Upper Sand
MW-120B	7/27/1993	Surficial	30.5	821.85	819.4	788.9	793.9	791.4	793.9	796.9	Upper Sand
MW-122A	8/6/1993	Surficial	21.5	806.45	803.4	781.9	791.9	786.9	794.0	797.4	Upper Sand/Peat
MW-122AR	3/31/1998	Surficial	19.3	807.25	804.0	784.7	794.7	789.7	795.9	800.0	Upper Sand/Peat
MW-122B	8/4/1993	Surficial	60.3	806.58	803.6	743.3	748.3	745.8	750.4	753.6	Lower Sand
MW-124A	8/23/1993	Surficial	36.0	843.74	841.3	805.3	815.3	810.3	817.3	820.3	Upper Sand
MW-124B	8/19/1993	Surficial	59.0	844.43	842.1	783.1	788.1	785.6	790.1	793.6	Upper Sand
MW-125A	8/22/1993	Surficial	25.0	810.05	807.7	783.2	788.2	785.7	788.3	791.3	Upper Sand/Peat
MW-126A	7/21/1993	Surficial	20.5	805.68	802.8	782.3	787.3	784.8	787.3	790.3	Upper Sand
MW-126AR	4/1/1998	Surficial	21.5	805.12	803.6	782.1	787.1	784.6	787.8	790.6	Upper Sand
MW-16B	6/13/1988	Surficial	33.0	803.26	801.9	768.9	771.9	770.4	773.9	800.9	Intermediate Sand
MW-19BR	8/20/1993	Surficial	39.0	822.06	819.5	780.5	785.5	783.0	787.5	790.3	Upper Aquitard[4]
MW-200A	10/4/2000	Surficial	15.8	803.73	800.9	785.1	790.1	787.6	791.9	793.9	Sand[3]
MW-201B	10/5/2000	Surficial	28.0	802.20	800.3	772.3	777.3	774.8	779.3	783.3	Sand[3]
MW-202B	9/24/2000	Surficial	35.0	803.73	801.1	767.9	772.6	770.3	774.6	778.1	Sand[3]
MW-203B	9/23/2000	Surficial	23.7	801.97	798.3	774.7	779.4	777.0	781.0	792.3	Sand[3]
MW-204B	10/9/2000	Surficial	84.0	807.05	800.6	716.6	721.6	719.1	727.0	745.6	Lower Sand
MW-205B	10/11/2000	Surficial	64.0	805.72	799.5	735.5	740.5	738.0	742.5	797.5	Lower Sand
MW-206A	6/10/2002	Surficial	12.0	800.85	797.7	785.7	790.7	788.2	791.2	795.7	Sand[3]
MW-207	5/31/2002	Surficial	33.0	805.00	797.9	765.3	769.9	767.6	771.9	774.9	Intermediate/Lower Sand[2]
MW-208	5/30/2002	Surficial	23.0	804.42	796.3	773.3	778.3	775.8	780.3	783.8	Intermediate/Lower Sand[2]
MW-209	6/17/2002	Surficial	33.0	792.40	787.0	754.0	759.0	756.5	761.0	764.0	Intermediate Sand

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MW-210	6/5/2002	Surficial	18.1	806.55	797.0	779.0	784.0	781.5	785.0	789.0	Sand[3]
MW-211	6/17/2002	Surficial	28.6	793.15	788.1	759.9	764.6	762.3	766.6	769.6	Intermediate Sand
MW-212	6/18/2002	Surficial	17.3	791.52	786.8	769.9	774.6	772.3	776.8	780.8	Intermediate Sand
MW-213	7/3/2002	Surficial	21.0	791.73	787.4	766.8	771.4	769.1	773.4	776.4	Intermediate Sand
MW-214	7/8/2002	Surficial	30.0	803.66	794.2	764.6	769.2	766.9	770.2	772.3	Upper Aquitard/Intermediate Sand
MW-215	3/31/2003	Surficial	6.0	790.56	783.6	777.8	782.6	780.2	783.1	784.6	Upper Sand
MW-216	3/28/2003	Surficial	9.6	790.54	783.6	774.2	779.0	776.6	779.5	781.6	Upper Sand
MW-217	3/28/2003	Surficial	9.6	790.79	783.2	774.7	776.7	775.7	777.2	780.2	Peat/Upper Sand
MW-218	3/28/2003	Surficial	12.0	790.73	783.5	771.7	776.5	774.1	777.0	780.5	Upper Sand
MW-219	3/28/2003	Surficial	13.5	790.97	788.9	775.6	780.4	778.0	780.9	784.9	Upper Sand
MW-220	3/31/2003	Surficial	6.0	790.81	785.9	780.1	784.9	782.5	785.4	786.9	Upper Sand
MW-221R	4/8/2003	Surficial	8.0	791.11	785.9	778.0	779.9	778.9	780.4	783.9	Upper Sand
MW-222	4/3/2003	Surficial	10.0	797.32	792.8	783.2	787.8	785.5	788.3	791.8	Peat/Upper Sand
MW-223	4/3/2003	Surficial	9.0	797.91	794.3	785.3	788.2	786.8	793.6	795.3	Upper Sand
MW-224	3/12/2003	Surficial	24.0	813.28	810.3	786.7	791.3	789.0	793.3	796.7	Upper Sand
MW-225	3/7/2003	Surficial	9.5	792.94	789.4	780.3	784.9	782.6	785.4	787.9	Upper Sand
MW-226	3/3/2003	Surficial	2.0	790.67	783.8	781.8	783.8	782.8	783.9	784.8	Upper Sand
MW-227	3/28/2003	Surficial	2.0	790.66	782.1	780.1	782.1	781.1	782.2	783.1	Upper Sand
MW-228	3/28/2003	Surficial	3.0	790.98	783.4	780.4	783.4	781.9	783.5	784.4	Upper Sand
MW-229	3/28/2003	Surficial	4.0	791.33	784.3	780.3	784.3	782.3	784.4	785.3	Upper Sand
MW-230	4/3/2003	Surficial	4.0	790.88	785.9	781.9	785.9	783.9	786.0	786.9	Upper Sand
MW-231	3/31/2003	Surficial	22.0	790.66	785.9	764.1	768.9	766.5	770.1	772.6	Intermediate Sand
MW-232	3/31/2003	Surficial	12.0	790.64	785.3	773.3	776.3	774.8	777.0	781.3	Upper Sand
OW-1A	2/17/2000	Surficial	20.5	803.08	806.7	786.3	788.3	787.3	788.8	792.2	Upper Sand
OW-1P	2/21/2000	Surficial	14.9	803.43	803.6	788.8	797.8	793.3	798.6	801.6	Upper Sand
OW-2A	2/22/2000	Surficial	18.5	804.01	804.6	786.2	788.1	787.2	788.5	791.6	Upper Sand/Upper Aquitard
OW-2B	2/21/2000	Surficial	34.4	803.80	804.4	770.4	775.2	772.8	776.9	780.2	Intermediate Sand/Lower Aquitard
OW-2P	2/22/2000	Surficial	15.5	804.21	804.7	789.3	794.1	791.7	795.2	797.9	Upper Sand
OW-3AR	9/28/2000	Surficial	15.0	803.91	799.1	784.1	788.7	786.4	790.1	792.1	Upper Sand
OW-3PR	9/28/2000	Surficial	8.4	807.21	798.9	790.9	795.7	793.3	796.6	797.9	Upper Sand/Peat
OW-4AR	9/27/2000	Surficial	25.0	809.41	804.2	779.2	783.8	781.5	785.2	786.7	Sand[3]
OW-4PR	6/25/2002	Surficial	8.4	811.26	801.4	793.0	800.5	796.8	800.5	801.4	Upper Sand
OW-5P	3/2/2000	Surficial	21.4	816.52	817.4	796.1	800.9	798.5	802.8	805.4	Upper Sand
OW-6A	3/3/2000	Surficial	31.9	817.32	818.2	786.3	791.1	788.7	792.4	794.7	Sand[3]
OW-6P	3/7/2000	Surficial	21.5	817.40	818.2	796.8	801.6	799.2	803.8	805.9	Residuals/Upper Sand

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Table 2-1 -- Allied OU - Monitoring Well Construction Data

Well/ Piezometer	Date Installed	Aquifer Unit	Total Depth of Monitoring Well (feet bgs)	Top of Casing Elevation (feet AMSL)	Ground Surface Elevation (feet AMSL)	Elevation of Bottom of Screen (feet AMSL)	Elevation of Top of Screen (feet AMSL)	Elevation of Mid Point of Screen (feet AMSL)	Elevation of Top of Filter Pack (feet AMSL)	Elevation of Top of Bentonite (feet AMSL)	Hydrostratigraphic Unit Screened Within Surficial Aquifer Unit (Units as Defined in RI)
OW-7PR	6/14/2000	Surficial	16.8	806.02	805.9	789.4	794.2	791.8	794.9	796.9	Upper Sand
OW-9PR	9/26/2000	Surficial	10.0	811.50	801.1	791.1	796.1	793.6	798.1	799.6	Upper Sand/Peat
OW-11A	10/7/2000	Surficial	18.5	804.01	799.4	781.2	785.9	783.6	787.9	789.9	Upper Sand
OW-12A	9/1/2000	Surficial	24.4	807.73	803.9	779.7	784.4	782.0	785.9	802.9 [1]	Upper Sand
OW-13A	10/3/2000	Surficial	14.8	800.77	798.0	783.4	786.2	784.8	787.0	788.5	Upper Sand
OW-14P	5/31/2002	Surficial	8.0	804.16	795.8	788.0	792.8	790.4	793.3	795.8	Upper Sand/Upper Aquitard
OW-15P	6/26/2002	Surficial	16.7	813.78	809.3	792.7	797.6	795.1	799.6	802.1	Upper Sand
OW-16P	6/26/2002	Surficial	7.1	806.06	797.7	790.7	795.6	793.1	796.7	797.7	Upper Sand
OW-17P	6/26/2002	Surficial	6.5	803.56	794.0	787.6	792.5	790.0	793.0	794.0	Upper Sand

Notes:

[1] Depth to top of grout; bentonite not present.

[2] The hydrostratigraphic unit screened is identified as lower sand or intermediate/lower sand; however, note that these unit descriptions refer to the lower portion of the *surficial* aquifer.

[3] Intervening clay layers are absent beneath the peat in this area of the Allied OU; therefore, the upper, intermediate and lower sand units can be thought of as one hydrostratigraphic unit within the surficial unit.

[4] Screens a sand seam within the upper aquitard.

RI = Remedial Investigation.
bgs = below ground surface.
AMSL = above mean sea level.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
TOC = Top of casing
Aquifer Unit designations are based on aquifer descriptions in Figure 2 from the April 30, 2008 MDEQ Memorandum from Brant Fisher to Paul Bucholtz.
Well construction data from 2008 Remedial Investigation Report (CDM, 2008), total depth of monitoring wells was added based on well construction logs.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
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Table 2-2 -- Neighboring Properties - Monitoring Well Construction Data

Well Number	Boring Log Available	Date Installed	Top of Casing Elevation (feet AMSL)[1]	Ground Elevation (feet AMSL)[1]	Screened Interval (feet bgs)	Top of Screen (feet AMSL)[1]	Bottom of Screen (feet AMSL)[1]	Aquifer Unit
Strebor Property								
MW-1	No	NA	802.79	801.2	11 - 16	790.2	785.2	Surficial
MW-7	No	NA	795.28	793.2	7 - 12	786.2	781.2	Surficial
MW-15	No	NA	797.23	796.2	5.5 - 10.5	790.7	785.7	Surficial
MW-21	No	NA	794.63	792.8	5 - 10	787.8	782.8	Surficial
MW-24	Yes	9/1/1987	799.97	797.6	5.3 - 13.1	792.3	784.5	Surficial
MW-25	Yes	9/7/1987	795.04	792.9	22.3 - 27.1	775.3	765.8	Surficial
MW-30	Yes	11/5/1987	796.32	793.8	9.7 - 14.7	784.1	779.1	Surficial
MW-35	Yes	11/13/1988	794.88	792.0	15.3 - 20.3	776.7	771.7	Surficial
MW-36	Yes	9/17/1990	788.55	785.7	2 - 12	783.7	773.7	Surficial
MW-37	Yes	9/18/1990	788.28	785.9	82 - 87	703.9	698.9	Regional
MW-38	Yes	9/19/1990	781.50	779.2	2.2 - 12.2	777.0	767.0	Surficial
MW-39	Yes	9/20/1990	781.55	778.9	80.5 - 85.5	698.4	693.4	Regional
MW-40	Yes	9/2/1990	796.51	794.1	87 - 92	707.1	702.1	Regional
Panelyte Property								
MW1	Yes	5/23/2002	797.16	794.6	7 - 17	787.6	777.6	Surficial
MW2	Yes	5/22/2002	795.98	793.6	5 - 15	788.6	778.6	Surficial
MW3	Yes	5/22/2002	799.44	797.0	6 - 16	791.0	781.0	Surficial
MW4	Yes	5/23/2002	795.33	793.0	4 - 14	789.0	779.0	Surficial
MW5	Yes	5/24/2002	795.05	792.5	2 - 12	790.5	780.5	Surficial
MW6	Yes	5/28/2002	792.70	795.0	4 - 14	791.0	781.0	Surficial
MW7	Yes	5/28/2002	795.40	793.3	4 - 14	789.3	779.3	Surficial
MW8	Yes	5/21/2002	795.90	793.3	6 - 16	787.3	777.3	Surficial
MW9	Yes	5/20/2002	781.11	778.9	1 - 3.5	777.9	775.4	Surficial
MW10	Yes	5/20/2002	781.56	779.1	4 - 5.7	775.1	773.4	Surficial
MW11	Yes	5/20/2002	782.95	780.8	3 - 5.5	777.8	775.3	Surficial
Performance Paper Property								
ATL-03	Yes	8/11/1990	777.38	773.6	10.2 - 15.2	763.4	758.4	Surficial
ATL-04	Yes	8/11/1990	780.27	777.6	19.7 - 24.7	757.9	752.9	Surficial
ATL-05	Yes	8/11/1990	773.42	769.9	9.6 - 14.6	760.3	755.3	Surficial
MW2-02	No	NA	783.40	781.0	13.1 - 18.1	767.9	762.9	Surficial
MW-3	No	NA	NA	NA	5 - 15	NA	NA	Surficial
MW3-01	No	NA	777.44	775.3	22 - 27	753.3	748.3	Surficial
MW3-02	No	NA	777.81	775.6	8.7 - 13.7	766.9	761.9	Surficial
MW3-04	No	NA	776.07	776.2	17.7 - 22.7	758.5	753.5	Surficial
MW-4	No	NA	NA	NA	15 - 25	NA	NA	Surficial
MW-5	No	NA	NA	NA	5 - 15	NA	NA	Surficial
MW-6	No	NA	780.27	777.7	13 - 23	764.7	754.7	Surficial
MW-7	No	NA	783.72	780.8	15 - 25	765.8	755.8	Surficial
MW-9	No	NA	787.64	784.8	15.4 - 20.4	769.4	764.4	Surficial
MW-10D	No	NA	781.52	778.5	33.6 - 38.6	744.9	739.9	Surficial
MW-10S	No	NA	780.73	778.1	10.9 - 15.9	767.2	762.2	Surficial

See Notes on Page 2.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
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Table 2-2 -- Neighboring Properties - Monitoring Well Construction Data

Well Number	Boring Log Available	Date Installed	Top of Casing Elevation (feet AMSL)[1]	Ground Elevation (feet AMSL)[1]	Screened Interval (feet bgs)	Top of Screen (feet AMSL)[1]	Bottom of Screen (feet AMSL)[1]	Aquifer Unit
Performance Paper Property (Cont.)								
MW-11	No	NA	778.96	776.1	8.3 - 13.3	767.8	762.8	Surficial
MW-12D	No	NA	771.65	768.8	28.7 - 33.7	740.1	735.1	Surficial
MW-12S	No	NA	771.41	768.6	6.4 - 11.4	762.2	757.2	Surficial
MW-13	No	NA	788.40	785.5	19.6 - 24.6	765.9	760.9	Surficial
MW-14	No	NA	767.76	764.5	3.2 - 8.2	761.3	756.3	Surficial
MW-15D	No	NA	779.79	777.1	35.8 - 40.8	741.3	736.3	Surficial
MW-15S	No	NA	779.72	777.2	15.1 - 20.1	762.1	757.1	Surficial
MW-16D	No	NA	777.36	774.5	31.5 - 36.5	743.0	738.0	Surficial
MW-16S	No	NA	776.94	774.5	12.3 - 17.3	762.2	757.2	Surficial
MWB-02	No	NA	783.25	780.5	17.3 - 22.3	763.2	758.2	Surficial
MWB-03	No	NA	NA	NA	20.4 - 25.4	NA	NA	Surficial
MWLTI	No	NA	NA	NA	16.3 - 21.3	NA	NA	Surficial
PW-1	No	NA	789.47	786.4	34.7 - 39.7	751.7	746.7	Surficial
PW-2	No	NA	786.18	783.0	22.1 - 27.1	760.9	755.9	Surficial
PW-3	No	NA	778.22	774.3	11.6 - 16.6	762.8	757.8	Surficial
PW-4	No	NA	775.63	772.6	12.6 - 17.6	760.0	755.0	Surficial
PW-5	No	NA	775.04	772.1	21.6 - 26.6	750.4	745.4	Surficial
PW-6	No	NA	774.24	771.0	24.2 - 29.2	746.9	741.9	Surficial

Notes:
bgs = below ground surface.
AMSL = above mean sea level.
NA = not available.
TOC = Top of casing.
[1] Surveyed by Prein & Newhof in 2009.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
Aquifer Unit designations are based on aquifer descriptions in Figure 2 from the April 30, 2008 MDEQ Memorandum from Brant Fisher to Paul Bucholtz.
Well Construction information for Performance Paper Property from Impacted Materials Assessment and Portage Creek Channel Restoration Summary Report for Performance Paper Site 315, 405, 505 E. Alcott Street Kalamazoo, Michigan 49001 URS, June 2006.
Well construction information for the Strebor Property from the Remedial Investigation and Feasibility Study for Strebor Inc., Kalamazoo, Inc., by Bay West, Inc., dated 7/24/1991.
Well construction information for Panelyte Site wells is from the Preliminary Site Assessment Report, Former Panelyte Site, Kalamazoo Michigan, Malcolm Pirnie, December 8, 2004.

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Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
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Table 2-3 -- Allied OU and Neighboring Properties - June 25-26, 2009 Groundwater and Surface Water Elevation Data

Well/ Piezometer	Hydrostratigraphic Unit Screened Within Surficial Aquifer Unit (Units as Defined in RI)	Top of Casing Elevation (feet AMSL)	6/25-6/26/09			Locations Used for Water Table Contour Map
			Depth to Water (ft below TOC)	Measured Depth to Bottom (ft below TOC)	Groundwater Elevation (feet AMSL)	
Allied OU						
FW-101	Upper Sand	800.36	4.66	7.51	795.70	X
GWE-1	Upper Sand/Peat/Upper Aquitard	803.21	19.95	24.90	783.26	
GWE-1A	Upper Sand/Upper Aquitard	806.07	18.12	NA	787.95	X
GWE-1P	NA	803.03	5.50	5.51	797.53	
GWE-4A	Upper Sand	805.27	22.65	40.91	782.62	
MW-5R	Peat/Upper Sand	811.87	18.77	28.09	793.10	
MW-6	Upper Sand	812.70	14.09	28.02	798.61	X
MW-7	Upper Sand	818.94	18.64	33.15	800.30	X
MW-8A	Peat/Upper Sand/Upper Aquitard	810.74	11.20	20.31	799.54	X
MW-22AR	Upper Sand/Peat	805.79	17.21	19.06	788.58	X
MW-22B	Intermediate/Lower Sand[1]	809.25	16.87	51.81	792.38	
MW-23R	Sand[2]	809.33	15.68	32.34	793.65	
MW-24R	Upper Sand/Upper Aquitard	803.37	Obstruction			
MW-26	Upper Sand	792.10	4.52	11.35	787.58	
MW-120A	Residuals/Upper Sand	822.21	21.15	26.34	801.06	X
MW-120B	Upper Sand	821.85	22.79	33.20	799.06	
MW-122A	Upper Sand/Peat	806.45	15.63	22.60	790.82	
MW-122AR	Upper Sand/Peat	807.25	15.87	16.70	791.38	X
MW-122B	Lower Sand	806.58	15.55	61.39	791.03	
MW-124A	Upper Sand	843.74	29.12	39.23	814.62	X
MW-124B	Upper Sand	844.43	40.75	61.34	803.68	
MW-125A	Upper Sand/Peat	810.05	16.99	27.14	793.06	X
MW-126A	Upper Sand	805.68	10.11	23.60	795.57	
MW-126AR	Upper Sand	805.12	11.03	23.45	794.09	X
MW-16B	Intermediate Sand	803.26	15.65	35.40	787.61	
MW-19BR	Upper Aquitard[3]	822.06	24.57	39.90	797.49	
MW-200A	Sand[3]	803.73	8.21	18.55	795.52	
MW-201B	Sand[3]	802.20	6.31	30.94	795.89	
MW-202B	Sand[3]	803.73	11.54	40.10	792.19	
MW-203B	Sand[3]	801.97	11.59	31.85	790.38	
MW-204B	Lower Sand	807.05	1.19	93.00	805.86	
MW-205B	Lower Sand	805.72	12.02	71.00	793.70	
MW-206A	Sand[3]	800.85	4.60	15.24	796.25	
MW-207	Intermediate/Lower Sand[1]	805.00	10.10	40.15	794.90	
MW-208	Intermediate/Lower Sand[1]	804.42	13.72	31.08	790.70	
MW-209	Intermediate Sand	792.40	0.00[4]	32.55	NA	
MW-210	Sand[2]	806.55	12.16	27.31	794.39	
MW-211	Intermediate Sand	793.15	1.41	33.53	791.74	
MW-212	Intermediate Sand	791.52	3.21	22.16	788.31	
MW-213	Intermediate Sand	791.73	0.20	25.08	791.53	
MW-214	Upper Aquitard/Intermediate Sand	803.66	16.03	40.06	787.63	
MW-215	Upper Sand	790.56	7.90	12.95	782.66	X
MW-216	Upper Sand	790.54	8.35	16.47	782.19	
MW-217	Peat/Upper Sand	790.79	7.88	17.53	782.91	
MW-218	Upper Sand	790.73	5.02	19.44	785.71	
MW-219	Upper Sand	790.97	6.48	20.41	784.49	
MW-220	Upper Sand	790.81	6.66	10.91	784.15	X
MW-221R	Upper Sand	791.11	9.03	13.31	782.08	
MW-222	Peat/Upper Sand	797.32	3.78	14.41	793.54	
MW-223	Upper Sand	797.91	5.16	9.65	792.75	X
MW-224	Upper Sand	813.28	22.39	27.00	790.89	X
MW-225	Upper Sand	792.94	5.60	12.59	787.34	
MW-226	Upper Sand	790.67	7.21	9.05	783.46	X
MW-227	Upper Sand	790.66	9.11	10.06	781.55	X
MW-228	Upper Sand	790.98	8.07	10.55	782.91	X
MW-229	Upper Sand	791.33	8.09	8.68	783.24	X
MW-230	Upper Sand	790.88	5.76	9.03	785.12	X

See Notes on Page 3.

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Table 2-3 -- Allied OU and Neighboring Properties - June 25-26, 2009 Groundwater and Surface Water Elevation Data

Well/ Piezometer	Hydrostratigraphic Unit Screened Within Surficial Aquifer Unit (Units as Defined in RI)	Top of Casing Elevation (feet AMSL)	6/25-6/26/09			Locations Used for Water Table Contour Map
			Depth to Water (ft below TOC)	Measured Depth to Bottom (ft below TOC)	Groundwater Elevation (feet AMSL)	
Allied OU (Cont.)						
MW-231	Intermediate Sand	790.66	3.98	28.98	786.68	
MW-232	Upper Sand	790.64	7.48	17.55	783.16	
OW-1A	Upper Sand	803.08	17.10	24.47	785.98	
OW-1P	Upper Sand	Not Located				
OW-2A	Upper Sand/Upper Aquitard	804.01	16.83	20.63	787.18	
OW-2B	Intermediate Sand/Lower Aquitard	803.80	14.04	36.30	789.76	
OW-2P	Upper Sand	804.21	17.15	17.69	787.06	X
OW-3AR	Upper Sand	803.91	16.19	22.13	787.72	
OW-3PR	Upper Sand/Peat	807.21	Dry/Damaged	16.00	NA	
OW-4AR	Sand[2]	809.41	Dry/Damaged	17.76	NA	
OW-4PR	Upper Sand	811.26	14.12	18.63	797.14	X
OW-5P	Upper Sand	816.52	Dry/Damaged	NA	NA	
OW-6A	Sand[2]	817.32	20.90	34.58	796.42	
OW-6P	Residuals/Upper Sand	817.40	18.11	23.96	799.29	X
OW-7PR	Upper Sand	806.02	16.26	19.58	789.76	
OW-9PR	Upper Sand/Peat	811.50	18.85	20.55	792.65	X
OW-11A	Upper Sand	804.01	15.03	22.53	788.98	
OW-12A	Upper Sand	807.73	20.39	32.28	787.34	
OW-13A	Upper Sand	800.77	14.85	21.84	785.92	
OW-14P	Upper Sand/Upper Aquitard	804.16	13.90	16.55	790.26	X
OW-15P	Upper Sand	813.78	17.49	20.40	796.29	X
OW-16P	Upper Sand	806.06	13.41	15.52	792.65	X
OW-17P	Upper Sand	803.56	14.18	16.08	789.38	X
Panelyte Property						
MW1	NA	797.16	8.10	20.04	789.06	X
MW2	NA	795.98	8.85	9.25	787.13	X
[2] The hydrostratigraphic unit screened is identified as lower sand or intermediate/lower sand; however, borings in this area of the Allied OU have not extended to a sufficient depth to locate	NA	799.44	5.25	16.55	794.19	X
MW4	NA	795.33	6.12	16.99	789.21	X
MW5	NA	795.05	6.61	14.90	788.44	X
MW6	NA	792.70	6.63	6.91	786.07	X
MW7	NA	795.40	8.15	9.00	787.25	X
MW8	NA	795.90	5.76	18.82	790.14	X
MW9	NA	781.11	2.39	5.75	778.72	X
MW10	NA	781.56	Damaged			
MW11	NA	782.95	1.95	8.05	781.00	X
Strebor Property						
MW-1	NA	802.79	10.46	NA	792.33	X
MW-7	NA	795.28	8.14	NA	787.14	X
MW-15	NA	797.23	9.11	NA	788.12	X
MW-21	NA	794.63	8.94	NA	785.69	X
MW-24	NA	799.97	9.61	NA	790.36	X
MW-25	NA	795.04	7.94	NA	787.10	
MW-30	NA	796.32	13	NA	783.32	X
MW-35	NA	794.88	9.05	NA	785.83	
MW-36	NA	788.55	9.59	NA	778.96	X
MW-37	NA	788.28	4.93	NA	783.35	
MW-38	NA	781.50	7.73	NA	773.77	X
MW-39	NA	781.55	8.09*	NA	789.64	
MW-40	NA	796.51	5.74	NA	790.77	
Performance Paper Property						
ATL-03	NA	777.38	10.10	18.96	767.28	X
ATL-04	NA	780.27	18.95	27.56	761.32	
ATL-05	NA	773.42	8.93	18.15	764.49	X
MW2-02	NA	783.40	17.02	20.65	766.38	X
MW-3	NA	NA	Not Located			
MW3-01	NA	777.44	13.23	29.06	764.21	
MW3-02	NA	777.81	13.66	16.10	764.15	X
MW3-04	NA	776.07	11.82	14.43	764.25	X

See Notes on Page 3.

Table 2-3 -- Allied OU and Neighboring Properties - June 25-26, 2009 Groundwater and Surface Water Elevation Data

Well/ Piezometer	Hydrostratigraphic Unit Screened Within Surficial Aquifer Unit (Units as Defined in RI)	Top of Casing Elevation (feet AMSL)	6/25-6/26/09			Locations Used for Water Table Contour Map
			Depth to Water (ft below TOC)	Measured Depth to Bottom (ft below TOC)	Groundwater Elevation (feet AMSL)	
Performance Paper Property (Cont.)						
MW-4	NA	NA	Not Located			
MW-5	NA	NA	Not Located			
MW-6	NA	780.27	14.09	28.02	766.18	X
MW-7	NA	783.72	21.72	28.19	762.00	X
MW-9	NA	787.64	16.59	23.46	771.05	
MW-10D	NA	781.52	11.65	41.70	769.87	
MW-10S	NA	780.73	13.38	18.40	767.35	X
MW-11	NA	778.96	7.45	16.23	771.51	X
MW-12D	NA	771.65	4.45	36.55	767.20	
MW-12S	NA	771.41	5.18	14.20	766.23	X
MW-13	NA	788.40	21.67	27.68	766.73	
MW-14	NA	767.76	6.17	11.67	761.59	X
MW-15D	NA	779.79	16.98	43.65	762.81	
MW-15S	NA	779.72	17.45	22.75	762.27	X
MW-16D	NA	777.36	15.50	39.57	761.86	
MW-16S	NA	776.94	15.10	19.98	761.84	X
MWB-02	NA	783.25	21.09	25.02	762.16	
MWB-03	NA	NA	Not Located			
MWLTI	NA	NA	Not Located			
PW-1	NA	789.47	21.02	41.03	768.45	
PW-2	NA	786.18	Damaged			
PW-3	NA	778.22	Damaged			
PW-4	NA	775.63	9.52	27.50	766.11	
PW-5	NA	775.04	9.53	23.34	765.51	
PW-6	NA	774.24	Damaged			
Surface Water Elevations						
SG-1	NA	NA	NA	NA	781.92	X
SG-2	NA	NA	NA	NA	791.30	X
SG-3 (Alcott Street Dam)	NA	NA	NA	NA	777.58	X
SG-4	NA	NA	NA	NA	769.22	X
SG-5	NA	NA	NA	NA	765.76	X
SG-6	NA	NA	NA	NA	763.41	X
Standing Water Gage on Allied OU	NA	NA	NA	NA	799.66	X

Notes:

[1] The hydrostratigraphic unit screened is identified as lower sand or intermediate/lower sand; however, note that these unit descriptions refer to the lower portion of the *surficial* aquifer.

[2] Intervening clay layers are absent beneath the peat in this area of the Allied OU; therefore, the upper, intermediate and lower sand units can be thought of as one hydrostratigraphic unit within the surficial unit.

[3] Well screens a sand seam within the upper aquitard.

[4] Groundwater level for MW-209 was at the top of casing.

RI = Remedial Investigation.

bgs = below ground surface.

AMSL = above mean sea level.

Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.

TOC = Top of casing.

NA = not available.

*Artesian well; measurement is in feet above ground surface and measurement was calculated based on a pressure reading.

Measurements collected on June 26, 2009 were collected while the groundwater exaction system was operating at the Strebor Property; measurements made on July 2, 2009 were collected during a system shutdown.

TOC elevations for non-Allied OU wells and surface water measuring points surveyed by Prein & Newhof in 2009.

Groundwater elevation measurements from the Strebor Property were made by Bay West personnel, while observed by ARCADIS personnel.

Aquifer Unit designations are based on aquifer descriptions in the Remedial Investigation Report (MDEQ, 2008a).

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table 2-4 -- Groundwater Elevation Data at Strebor and Nearby Wells Under Non-Pumping Conditions July 2, 2009

Well Number	Aquifer Unit	7/2/2009	
		Depth to Water (ft below TOC)	Groundwater Elevation (feet AMSL)
Panelyte Property			
MW1	Surficial	8.14	789.02
MW2	Surficial	8.01	787.97
MW7	Surficial	8.29	787.11
MW9	Surficial	1.51	779.60
Strebor Property[1]			
MW-1	Surficial	10.48	792.31
MW-7	Surficial	7.80	787.48
MW-15	Surficial	8.12	789.11
MW-21	Surficial	8.08	786.55
MW-24	Surficial	9.46	790.51
MW-25	Surficial	7.53	787.51
MW-30	Surficial	13.06	783.26
MW-35	Surficial	7.73	787.15
MW-36	Surficial	9.57	778.98
MW-37	Regional	4.89	783.39
MW-38	Surficial	7.82	773.68
MW-39	Regional	8.09*	789.64
MW-40	Regional	5.76	790.75
Performance Paper Property			
ATL-03	Surficial	10.38	767.00
ATL-05	Surficial	9.25	764.17
MW-11	Surficial	7.54	771.42
MW-12S	Surficial	5.43	765.98
Surface Water Elevations			
Alcott Street Dam (SG-3)	Portage Creek	11.77	777.61
SG-4	Portage Creek	19.81	769.12

Notes:
bgs = below ground surface.
AMSL = above mean sea level.
NM = not measured.
TOC = Top of casing.
*Artesian well; measurement is in feet above ground surface and measurement was calculated based on a pressure reading.
Aquifer Unit designations are based on aquifer descriptions in Figure 2 from the April 30, 2008 MDEQ Memorandum from Brant Fisher to Paul Bucholtz.
[1] Measurements were made by Bay West personnel and observed by ARCADIS personnel.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
The groundwater extraction system at Strebor was temporary shut down on 7/1/09.
The average pumping rate is approximately 125 gallons per minute.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River/Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table 2-5 - City of Kalamazoo Central Well Field 2006 and 2008 PCB Sampling Data

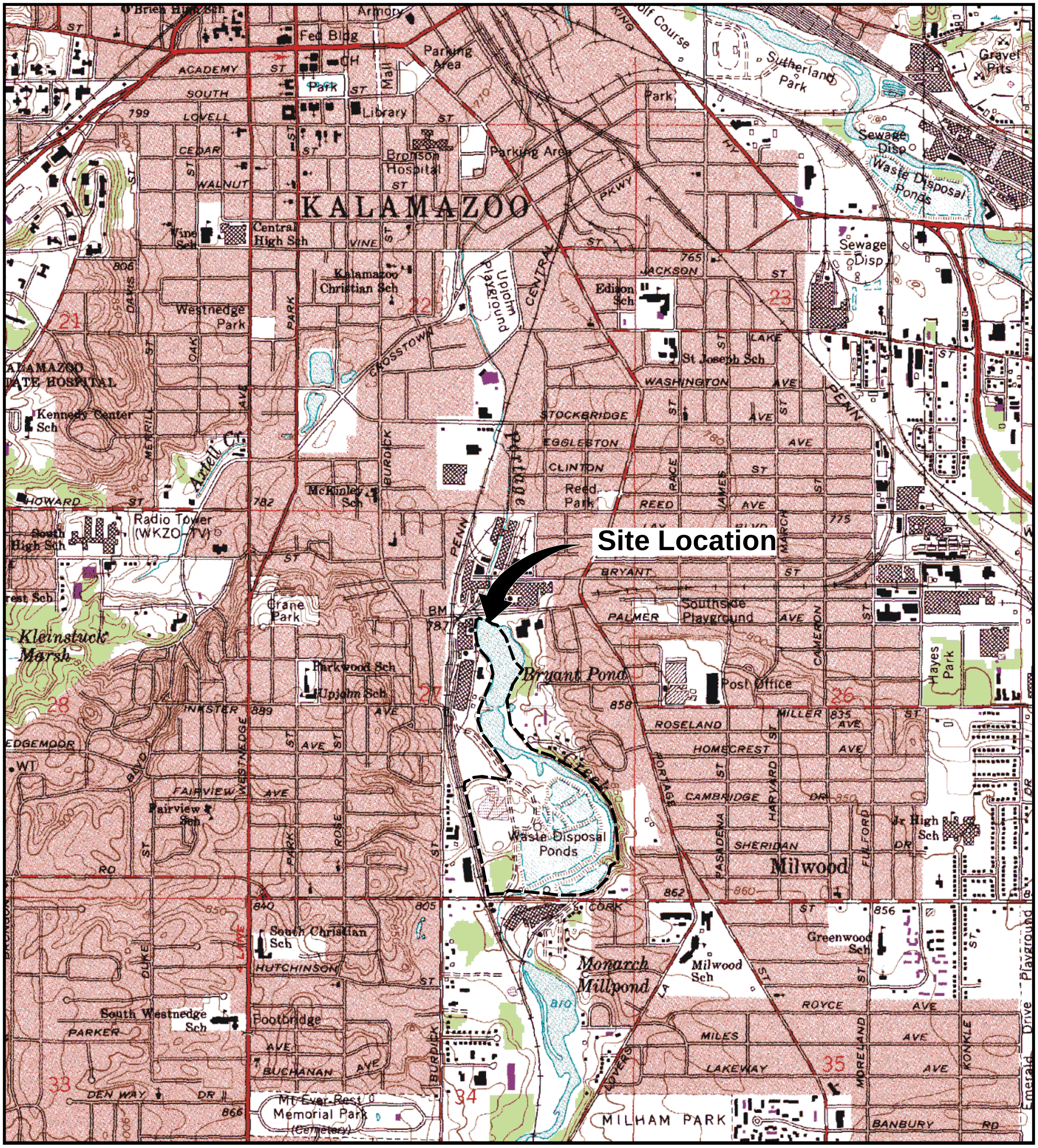
Sample Date	Pumping Station ID	Sample No.	Sample ID	Total PCB (µg/L)[1]
6/28/2006	2	LA 94908	E002 STATION 2	ND (0.05 U)
6/24/2006	1	LA 94908	C001 Central	ND (0.05 U)
8/4/2008	NA	083151-01	"08-217-1-3"	ND (0.05 U)
8/4/2008	NA	083151-02	"08-217-1-5"	ND (0.05 U)
8/4/2008	NA	083151-03	"08-217-1-6"	ND (0.05 U)
8/4/2008	NA	083151-04	"08-217-1-1"	ND (0.05 U)
8/4/2008	NA	083151-07	"08-217-1-4"	ND (0.05 U)
8/4/2008	NA	083151-08	"08-217-1-2"	ND (0.05 U)
8/4/2008	NA	083151-09	"08-217-3-4"	ND (0.05 U)
8/4/2008	NA	083151-10	"08-217-3-5"	ND (0.05 U)
8/4/2008	NA	083151-11	"08-217-3-1"	ND (0.05 U)
8/4/2008	NA	083151-12	"08-217-3-3"	ND (0.05 U)
8/27/2008	3	083589-01	"Sta. 3-2-A, Well 2-A Station 3"	ND (0.05 U)

Notes:
[1]Total PCB included Aroclor 1016, 1221, 1232, 1242, 1248, 1254 and 1260.
ND = not detected.
NA = not available.
µg/L = micrograms per liter.
The analytical data for the City Drinking water chemical analytical results were provided by the City to the USEPA, and subsequently provided to MHLLC by USEPA on September 29, 2008.

Note Explaining Data Qualifiers:
U = The compound was analyzed for but not detected. The associated value is the compound quantitation limit.

ARCADIS

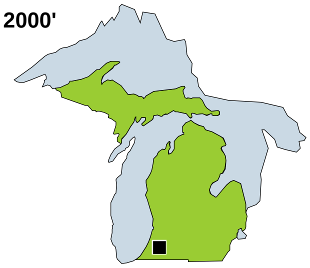
Figures



REFERENCE: BASE MAP SOURCE USGS 7.5 MINUTE QUAD. SERIES KALAMAZOO, MICHIGAN, 1967. (PHOTO REVISED 1973).

2000' 0 2000'

Approximate Scale: 1" = 2000'



Quadrangle Location

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

SITE LOCATION MAP

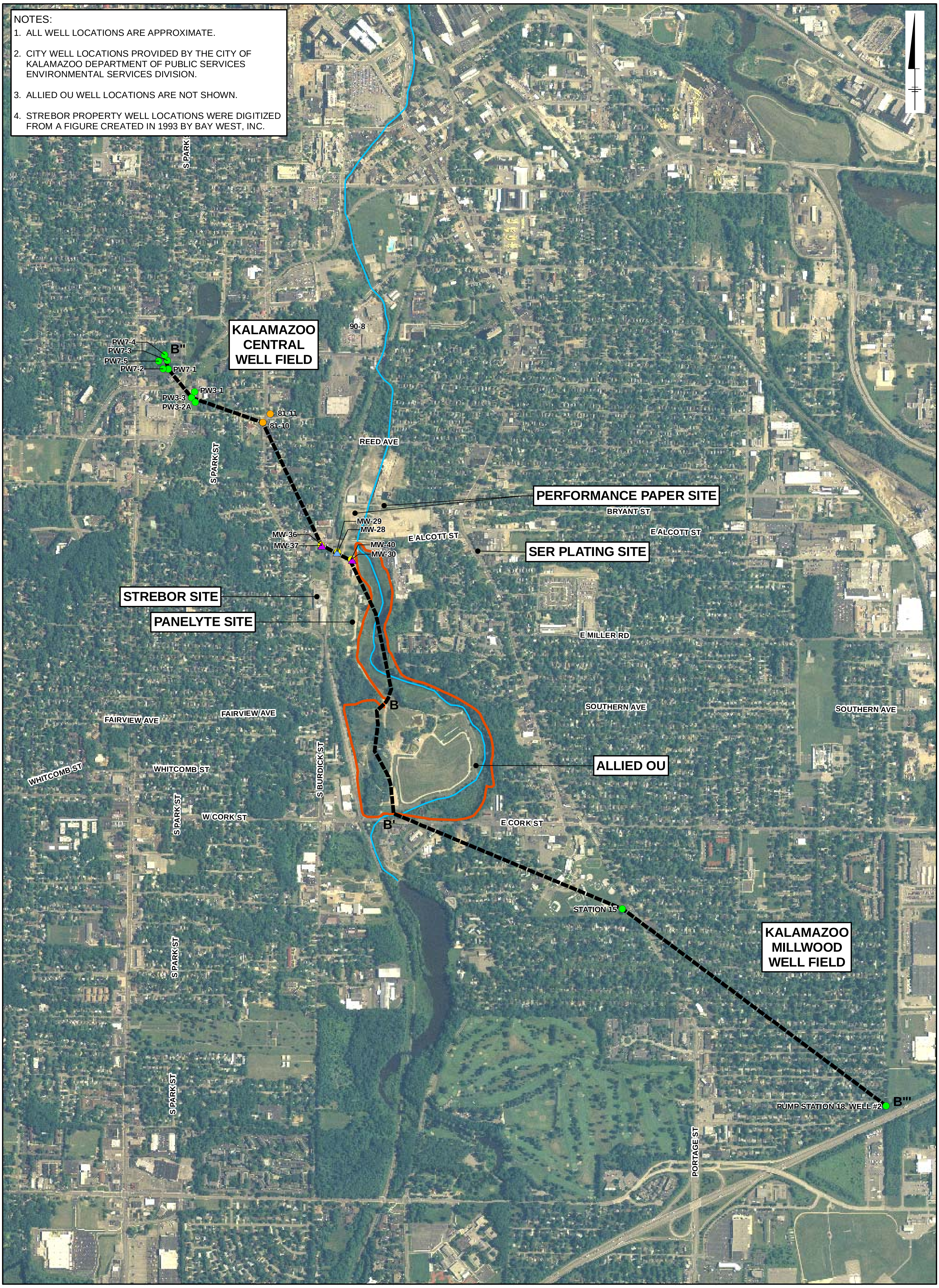
ARCADIS

FIGURE
1-1

08/25/09 SYRACUSE-141ENV-DJHOWES
B0064587/0001/00003/CDR/64587N01.CDR

SYR-90 JCR MTK JCR
KRSG - Allied OU (B0064587.0001.00003)
Q:\KRSG\WaterWellLocations\AlliedOU\mxd\CrossSectionLocationMap_v3.mxd - 9/29/2009 @ 4:31:01 PM

NOTES:
1. ALL WELL LOCATIONS ARE APPROXIMATE.
2. CITY WELL LOCATIONS PROVIDED BY THE CITY OF KALAMAZOO DEPARTMENT OF PUBLIC SERVICES ENVIRONMENTAL SERVICES DIVISION.
3. ALLIED OU WELL LOCATIONS ARE NOT SHOWN.
4. STREBOR PROPERTY WELL LOCATIONS WERE DIGITIZED FROM A FIGURE CREATED IN 1993 BY BAY WEST, INC.



LEGEND:
- CITY MONITORING WELL
- CITY PRODUCTION WELL
- STREBOR PROPERTY WATER TABLE MONITORING WELL
- STREBOR PROPERTY INTERMEDIATE MONITORING WELL
- STREBOR PROPERTY DEEP MONITORING WELL
- ALLIED PAPER, INC. OPERABLE UNIT BOUNDARY (APPROXIMATE)
- PORTAGE CREEK CENTERLINE (APPROXIMATE)
- LINE OF CROSS SECTION

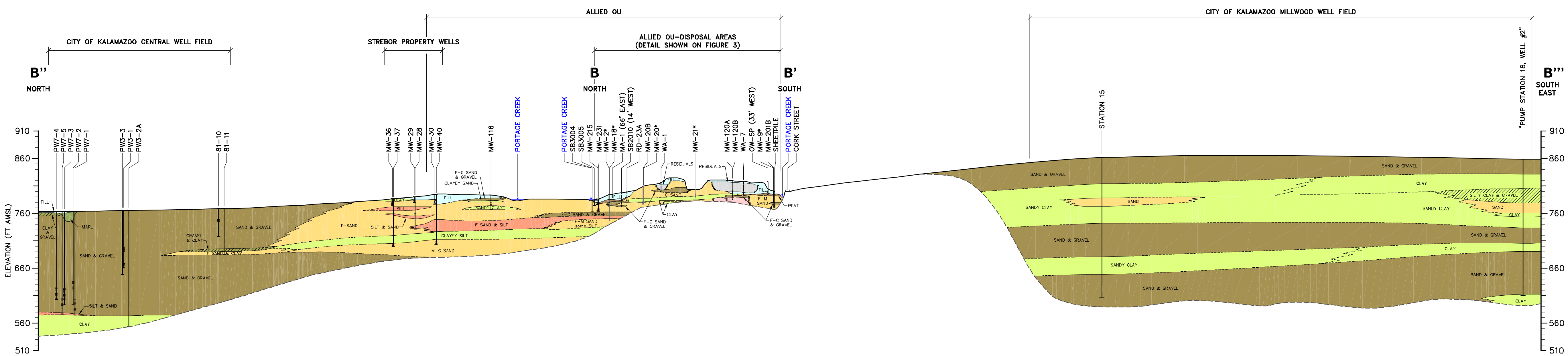
0 1,300 2,600 Feet
GRAPHIC SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

CROSS-SECTION LOCATION MAP

ARCADIS

FIGURE
1-2



0 100' 200'
VERTICAL SCALE
0 600' 1200'
HORIZONTAL SCALE

NOTES:

1. SURFACE ELEVATIONS FROM TOPOGRAPHIC MAPPING BY LOCKWOOD MAPPING, INC., AND MONITORING WELL/BORING SURVEY DATA.
2. AMSL = ABOVE MEAN SEA LEVEL (NGVD OF 1929).

FILL: CONSISTS CHIEFLY OF A HETEROGENEOUS MIXTURE OF SAND AND SILT WITH VARIABLE AMOUNTS OF GRAVEL AND OCCASIONAL DISCONTINUOUS INTERVALS OF REWORKED PEAT. MAY CONTAIN TRACE AMOUNTS OF RESIDUALS.

RESIDUALS: RESIDUALS MAY CONTAIN THIN LAYERS OF SAND OR OTHER FILL.

SAND AND GRAVEL: INTERBEDDED SAND AND GRAVELS, MAY CONTAIN SMALL AMOUNTS OF SILT AND CLAY.

MARL: UNCONSOLIDATED DEPOSITS OF CLAY AND CALCIUM CARBONATE.

PEAT: DEPOSITS OF POST-GLACIAL AGE CONSISTING OF PEAT OR ORGANIC-RICH SILT OR CLAY.

SAND: PREDOMINANT GRAIN SIZE OF SAND SHOWN AS FINE [f], MEDIUM [m], OR COARSE [c]. MAY CONTAIN SMALL AMOUNTS OF CLAY, SILT, OR GRAVEL.

CLAY: CLAY MAY CONTAIN SMALL AMOUNTS OF f-c SAND AND SILT.

SILT: SILT MAY CONTAIN SMALL AMOUNTS OF f-c SAND AND CLAY.

TILL: A GENERALLY HARD DEPOSIT WITH LITTLE OR NO SORTING AND CONSISTING CHIEFLY OF f SAND, SILT, AND/OR CLAY IN VARYING PROPORTIONS, WITH LESSER AMOUNTS OF m-c SAND AND GRAVEL. MAY CONTAIN OCCASIONAL, DISCONTINUOUS LENSES OF SILT, SAND, AND/OR GRAVEL.

GRAVEL AND CLAY

LEGEND:

SB2010 (14' WEST)*

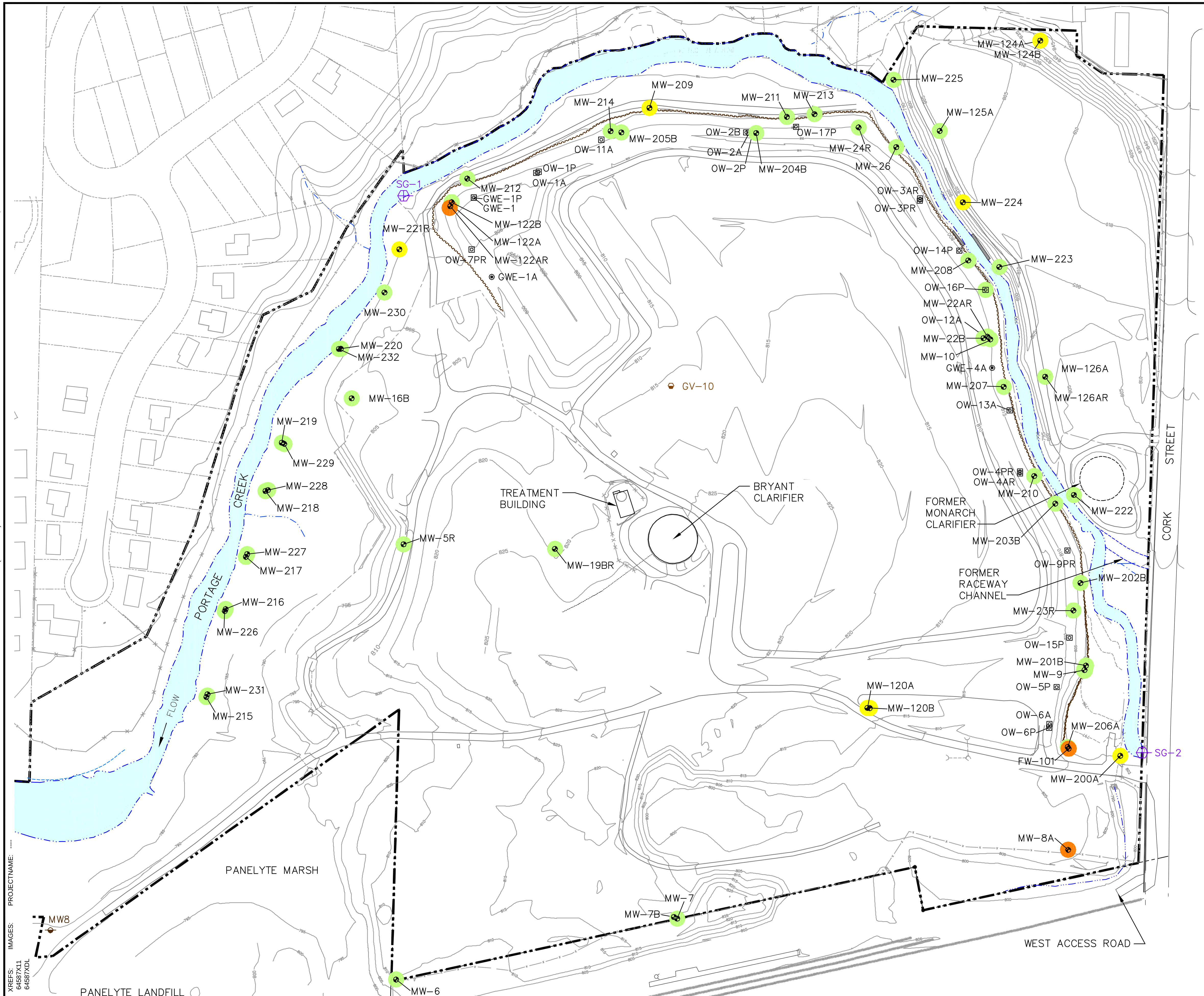
- NOT CONTINUOUSLY SAMPLED. SAMPLED AT 5 FOOT INTERVALS.
- DISTANCE AND DIRECTION FROM WHICH BORING/WELL IS PROJECTED ONTO SECTION LINE (IF GREATER THAN 10 FEET)
- BORING/WELL ID
- SOIL BORING
- MONITORING WELL
- SCREENED INTERVAL
- BOTTOM OF BORING
- INFERRED BOUNDARY
- LIMIT OF AVAILABLE DATA

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GEOLOGIC CROSS SECTION B"-B-B'-B'''

ARCADIS

FIGURE
1-3



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G:\ENVCAD\SYRACUSE\ACT\B0064587\0001\00004\DWG\64587P05.DWG LAYOUT: 1:4 SAVED: 9/2/2009 2:51 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/3/2009 1:45 PM BY: JONES, WENDY
XREFS: 64587X11 64587XDL IMAGES: PROJECTNAME: ----

LEGEND:

- EDGE OF WATER OR DRAINAGE CHANNEL
- SHEETPILE LOCATION
- SURVEYED PROPERTY BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY
- TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
- RAILROAD TRACK
- ROAD/TRAIL
- MW-26 MONITORING WELL
- OW-12A PIEZOMETER LOCATION
- GWE-1A RECOVERY WELL LOCATION
- MONITORING WELL SAMPLED IN 2002 AND/OR 2003; PCBs NOT DETECTED
- MONITORING WELL SAMPLED IN 2002 AND/OR 2003; PCBs DETECTED ABOVE GSI CRITERIA
- MONITORING WELL SAMPLED IN 2002 AND/OR 2003; PCBs DETECTED BUT BELOW CRITERIA IN ONE OR BOTH SAMPLES

NOTES:

1. TOPOGRAPHIC MAPPING NORTH OF FORMER TYPE III LANDFILL AREA, AND BRYANT HRDLs/FRDLs PRODUCED USING PHOTOGRAMETRIC METHODS BY LOCKWOOD, INC. FROM AERIAL PHOTOGRAPHY FLOWN MAY 1991. BASE MAP INFORMATION WITHIN FORMER TYPE III LANDFILL AREA AND AREA NORTH OF WESTERN DISPOSAL AREA FIELD SURVEY OBTAINED FROM PLAN ENTITLED "TOPOGRAPHIC AND BOUNDARY SURVEY OF ALLIED PAPER, INC. KALAMAZOO, MI. SECTION 27. TOWN 2 SOUTH, RANGE 11 WEST," PREPARED BY WADE-TRIM, INC., DATED 7/8/99. BASE MAP INFORMATION WITHIN BRYANT HRDLs/FRDLs AREA OBTAINED FROM PLAN ENTITLED "AS BUILT SURVEY OF ALLIED PAPER SITE" PREPARED BY PREIN AND NEWHOF, KALAMAZOO, MI. DATED 1/27/05 (PROJECT NO. 2000171K). TOPOGRAPHIC CONTOUR LINES INSIDE THE MONARCH HRDL AREA SURVEYED BY PREIN & NEWHOF SURVEYORS ON 4/03. NGVD 1929. BASE MAP INFORMATION IN THE WESTERN DISPOSAL AREA BASED ON TOPOGRAPHIC SURVEY PERFORMED BY PREIN & NEWHOF, DRAWING FILE NUMBER 2060643K, DATED SEPTEMBER 27, 2006.
2. ELEVATIONS ARE REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) 1929.
3. COORDINATE GRID IS REFERENCED TO THE MICHIGAN STATE PLANE (SOUTH ZONE) COORDINATE SYSTEM (NAD83).
4. ALLIED PROPERTY LINES ESTABLISHED USING: WADE-TRIM SURVEY (9/1999)-NORTHERN PARCEL ONLY; ATWELL HICKS, INC. SURVEY (11/2002); AND PREIN AND NEWHOF SURVEY (12/2002).
5. PORTAGE CREEK OUTLINE WITHIN THE ALLIED PROPERTY UPDATED ON 12/4/02 USING DIGITAL ORTHOGRAPHY BY AIR LAND SURVEYS, INC.(4/24/00) SCANNED FROM CDM DRAWING DETSVR/DETL007770/C:/PROJ/28963/_GIS/OU1/OU1_REPORT.APR REVISED 11/10/02. PORTAGE CREEK OUTLINE NORTH OF THE ALLIED PROPERTY UPDATED ON 12/4/02 USING A CDM CREEK OUTLINE PREPARED ON 9/23/02 PROVIDED ON COMPACT DISK.

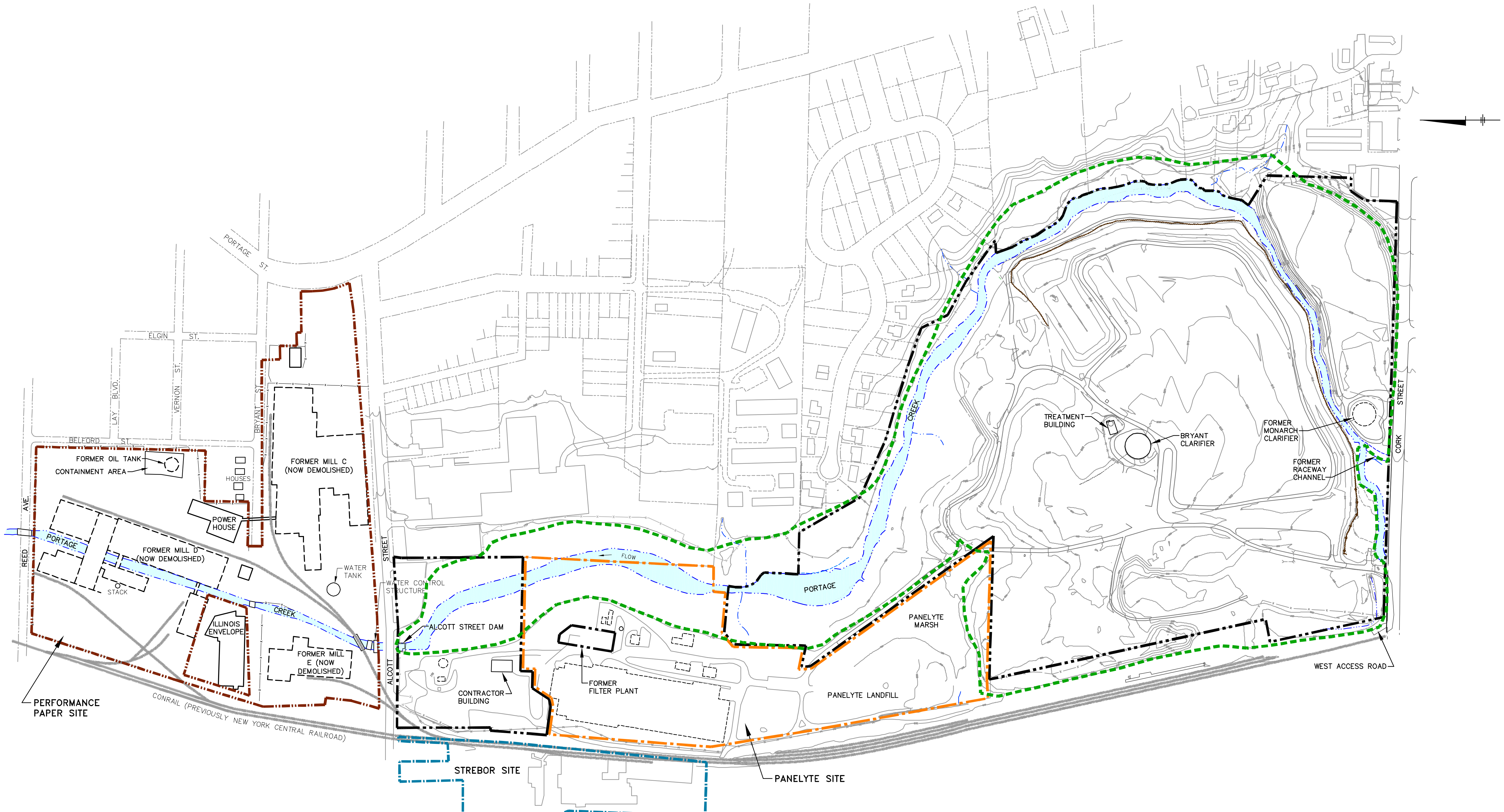
0 100' 200'
GRAPHIC SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

PCB DETECTIONS IN GROUNDWATER 2002 - 2003

ARCADIS

FIGURE
1-4



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2. ELEVATIONS ARE REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) 1929.
3. COORDINATE GRID IS REFERENCED TO THE MICHIGAN STATE PLANE (SOUTH ZONE) COORDINATE SYSTEM (NAD83).
4. ALLIED PROPERTY LINES ESTABLISHED USING: WADE-TRIM SURVEY (9/1999)-NORTHERN PARCEL ONLY; ATWELL HICKS, INC. SURVEY (11/2002); AND PREIN AND NEWHOF SURVEY (12/2002).
5. PORTAGE CREEK OUTLINE WITHIN THE ALLIED PROPERTY UPDATED ON 12/4/02 USING DIGITAL ORTHOGRAPHY BY AIR LAND SURVEYS, INC.(4/24/00) SCANNED FROM CDM DRAWING DETSVR/DETL007770/C:/PROJ/28963/_GIS/OU1/OU1_REPORT.APR REVISED 11/10/02. PORTAGE CREEK OUTLINE NORTH OF THE ALLIED PROPERTY UPDATED ON 12/4/02 USING A CDM CREEK OUTLINE PREPARED ON 9/23/02 PROVIDED ON COMPACT DISK.
6. PERFORMANCE PAPER, STREBOR AND PANELYTE SITE MONITORING WELLS SURVEY BY PREIN AND NEWHOF (6/2009).
7. PANELYTE SITE LIMITS WERE DIGITIZED FROM A HARD COPY OF FIGURE 2-1 FROM THE MALCOLM PIRNIE "PRELIMINARY SITE ASSESSMENT REPORT", DATED 12/8/04, AT A SCALE OF 1"=200', AND ARE APPROXIMATE.
8. STREBOR PROPERTY BOUNDARY AND BUILDING DIGITIZED FROM A HARD COPY DOWNLOADED FROM THE CITY OF KALAMAZOO – ONLINE GIS SITE AND ARE APPROXIMATE.

LEGEND:

- EDGE OF WATER OR DRAINAGE CHANNEL
- SHEETPILE LOCATION
- SURVEYED ALLIED OU PROPERTY BOUNDARY
- APPROXIMATE PERFORMANCE PAPER PROPERTY BOUNDARY
- APPROXIMATE PANELYTE SITE LIMITS
- APPROXIMATE STREBOR PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF ALLIED-OU
- TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
- RAILROAD TRACK
- ROAD/TRAIL

0 400' 800'

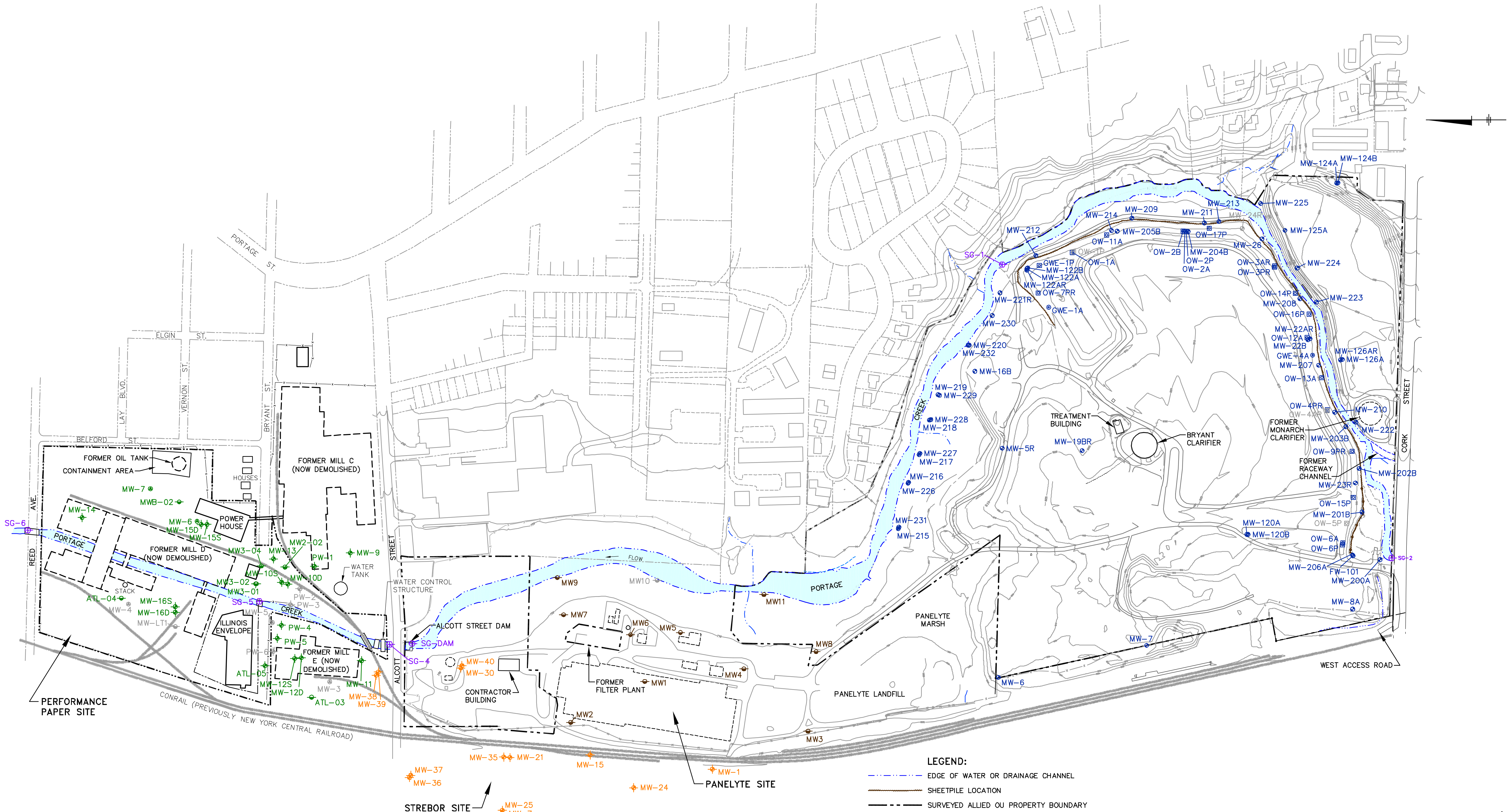
GRAPHIC SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK /
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

NEIGHBORING PROPERTY LOCATION MAP

ARCADIS

FIGURE
2-1



NOTES:

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2. ELEVATIONS ARE REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) 1929.
3. COORDINATE GRID IS REFERENCED TO THE MICHIGAN STATE PLANE (SOUTH ZONE) COORDINATE SYSTEM (NAD83).
4. ALLIED PROPERTY LINES ESTABLISHED USING: WADE-TRIM SURVEY (9/1999)-NORTHERN PARCEL ONLY; ATWELL HICKS, INC. SURVEY (11/2002); AND PREIN AND NEWHOF SURVEY (12/2002).
5. PORTAGE CREEK OUTLINE WITHIN THE ALLIED PROPERTY UPDATED ON 12/4/02 USING DIGITAL ORTHOGRAPHY BY AIR LAND SURVEYS, INC.(4/24/00) SCANNED FROM CDM DRAWING DETSVR/DETL007770/C:/PROJ/28963/_GIS/OU1/OU1_REPORT.APR REVISED 11/10/02. PORTAGE CREEK OUTLINE NORTH OF THE ALLIED PROPERTY UPDATED ON 12/4/02 USING A CDM CREEK OUTLINE PREPARED ON 9/23/02 PROVIDED ON COMPACT DISK.
6. PERFORMANCE PAPER, STREBOR AND PANELYTE SITE MONITORING WELLS SURVEY BY PREIN AND NEWHOF (6/2009).

LEGEND:

		EDGE OF WATER OR DRAINAGE CHANNEL
		SHEETPILE LOCATION
		SURVEYED ALLIED OU PROPERTY BOUNDARY
		APPROXIMATE PERFORMANCE PAPER PROPERTY BOUNDARY
		TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
		RAILROAD TRACK
		ROAD/TRAIL
ALLIED OU	MW-26	MONITORING WELL
	OW-12A	PIEZOMETER LOCATION
	GWE-1A	RECOVERY WELL LOCATION
PANELYTE	MW1	MONITORING WELL INSTALLED BY PANELYTE
STREBOR	MW-1	STREBOR WELL LOCATION
PERFORMANCE PAPER	MW-16S	MONITORING WELL (ECT-2005)
	MW-4	MONITORING WELL (ATLANTIC TESTING-1990)
	SG-2	EXISTING SURFACE WATER STAFF GAUGE
	MW-4	MONITORING WELL NOT LOCATED OR DAMAGED

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK /
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

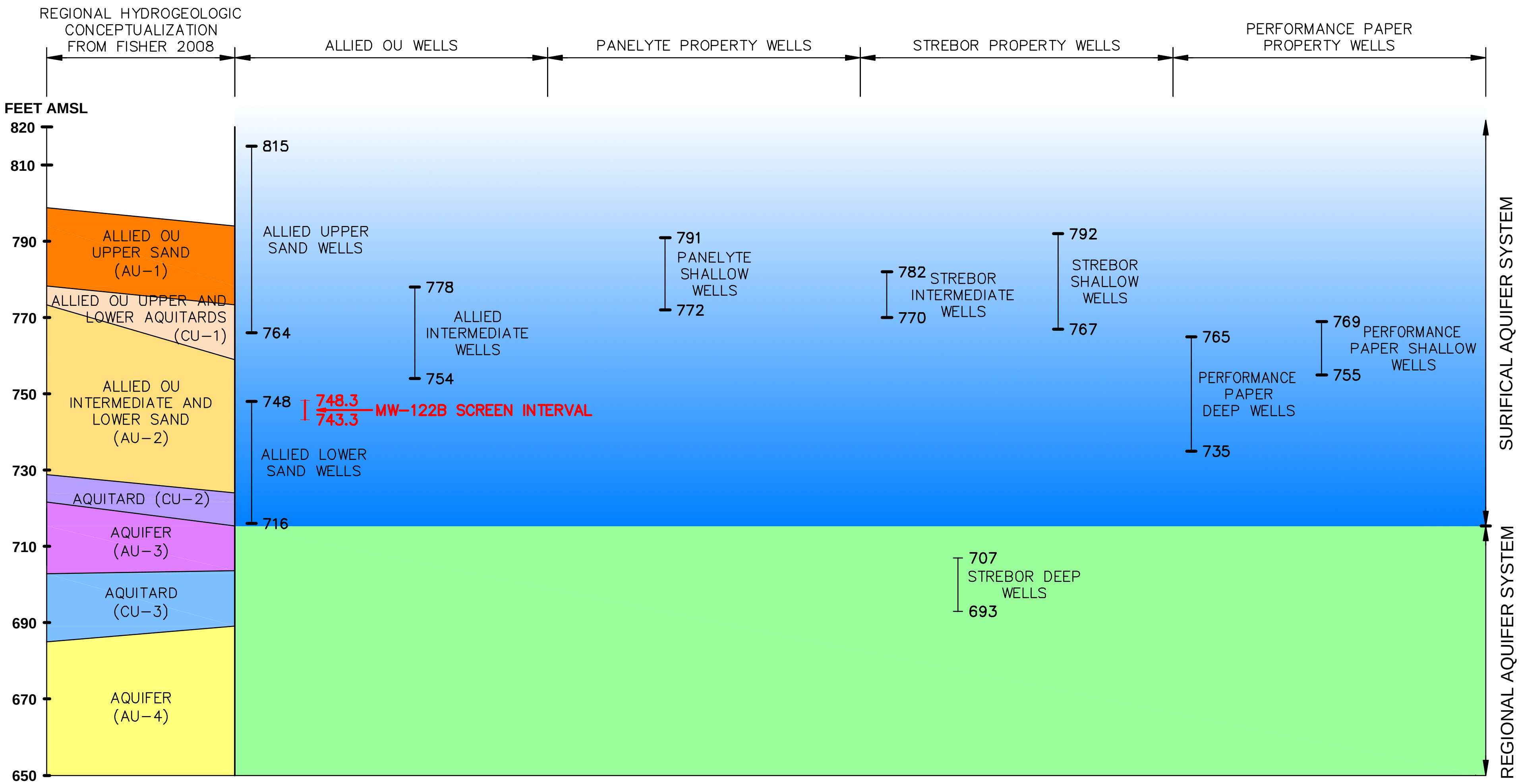
GROUNDWATER INVESTIGATION MONITORING LOCATIONS

ARCADIS

FIGURE
2-2

CITY: SYRACUSE, NY GROUP: ENVCAD-141 DB: R.ALLEN, P. LISTER, R.ALLEN PM: T. GRANZEIER TM: L. COFFEY TR: J. ROBERTSON LYR:ON=*;OFF=*REF* PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/3/2009 2:59 PM BY: JONES, WENDY
G:\ENVCAD\SYRACUSE\ACT\B0064587\0001\00004\DWG\64587B08.DWG LAYOUT: 2-2 SAVED: 9/3/2009 2:58 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: ----
XREFS: 64587X11 64587XDL IMAGES: PROJECTNAME: ----

CITY: SYRACUSE, NY GROUP: ENVCAD-141 DB: G.STOWELL, P. LISTER, R.ALLEN PM: T. GRANZEIER TM: L. COFFEY TR: J. ROBERTSON LYR: ON=*;OFF=REF
G:\ENVCAD\SYRACUSE\ACT\B0064587\0001\00004\DWG\PRESENTATION\64387N02.dwg LAYOUT: 2-3SAVED: 9/3/2009 2:56 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: ----PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/3/2009 2:57 PM BY: JONES, WENDY
XREFS: IMAGES: PROJECTNAME: ----



NOTES:

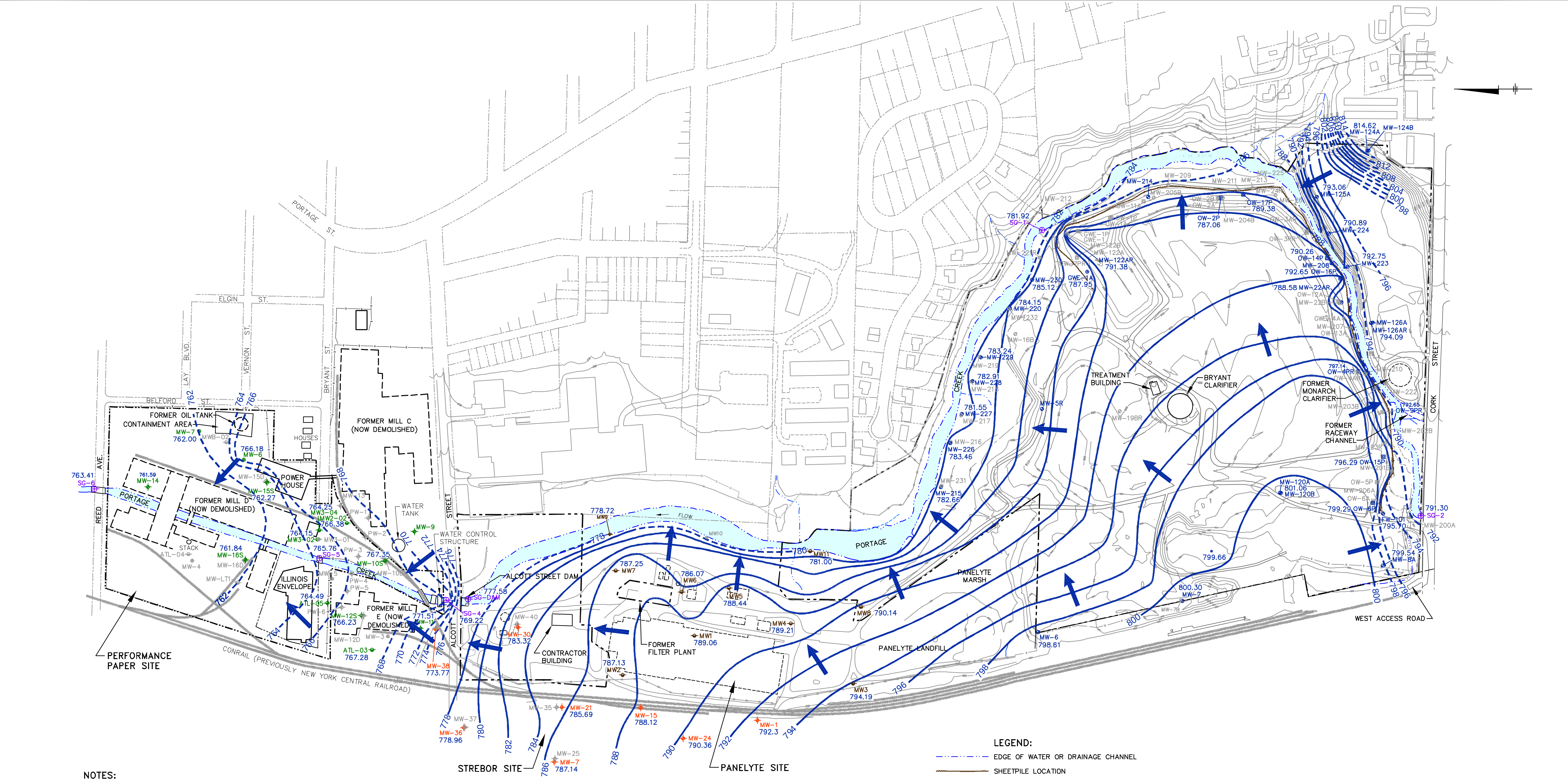
1. REGIONAL HYDROGEOLOGIC CENCEPTUALIZATION ADAPTED FROM FIGURE 2 FROM BRANT FISHER, APRIL 30 2008 MDEQ MEMORANDUM TO PAUL BUCHOLTZ, TITLED HYDROGEOLOGIC CONCEPTUALIZATION.
2. MONITORING WELL ELEVATION RANGES SHOWN ARE ONLY FOR MONITORING WELLS INCLUDED IN JUNE 2009 GROUNDWATER INVESTIGATION.

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

MONITORING WELL SCREEN INTERVALS RELATIVE TO REGIONAL HYDROGEOLOGIC UNITS

ARCADIS

FIGURE
2-3



NOTES:

1. TOPOGRAPHIC MAPPING NORTH OF FORMER TYPE III LANDFILL AREA, AND BRYANT HRDLs/FRDLs PRODUCED USING PHOTOGRAMETRIC METHODS BY LOCKWOOD, INC. FROM AERIAL PHOTOGRAPHY FLOWN MAY 1991. BASE MAP INFORMATION WITHIN FORMER TYPE III LANDFILL AREA AND AREA NORTH OF WESTERN DISPOSAL AREA FIELD SURVEY OBTAINED FROM PLAN ENTITLED "TOPOGRAPHIC AND BOUNDARY SURVEY OF ALLIED PAPER, INC. KALAMAZOO, MI. SECTION 27. TOWN 2 SOUTH, RANGE 11 WEST," PREPARED BY WADE-TRIM, INC., DATED 7/8/99. BASE MAP INFORMATION WITHIN BRYANT HRDLs/FRDLs AREA OBTAINED FROM PLAN ENTITLED "AS BUILT SURVEY OF ALLIED PAPER SITE" PREPARED BY PREIN AND NEWHOF, KALAMAZOO, MI. DATED 1/27/05 (PROJECT NO. 2000171K). TOPOGRAPHIC CONTOUR LINES INSIDE THE MONARCH HRDL AREA SURVEYED BY PREIN & NEWHOF SURVEYORS ON 4/03. NGVD 1929. BASE MAP INFORMATION IN THE WESTERN DISPOSAL AREA BASED ON TOPOGRAPHIC SURVEY PERFORMED BY PREIN & NEWHOF, DRAWING FILE NUMBER 2060643K, DATED SEPTEMBER 27, 2006. BASE MAP INFORMATION AND PERFORMANCE PAPER WELL LOCATIONS BY MACTEC (2002), AND ATLANTIC TESTING (1990) NORTH OF ALCOTT STREET PREPARED BY DIGITIZING A PAPER COPY OF A PDF OF A DRAWING MADE BY "FISHBECK, THOMPSON, CARR & HUBER ENGINEERS-SCIENTISTS-ARCHITECTS" TITLED BASELINE ENVIRONMENTAL ASSESSMENT-SITE PLAN PROJECT NUMBER G03561A, DATED 2005, AT A SCALE OF 1"=150'. PERFORMANCE PAPER WELL LOCATIONS BY "ENVIRONMENTAL CONSULTING & TECHNOLOGY, INC." (ECT), DIGITIZED FROM PAPER COPY OF A PDF OF A DRAWING MADE BY "ECT" TITLED "SITE MAP WITH SAMPLING LOCATIONS – FIGURE 4", DATED 2005, AT A SCALE OF 1"=200'.
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5. PORTAGE CREEK OUTLINE WITHIN THE ALLIED PROPERTY UPDATED ON 12/4/02 USING DIGITAL ORTHOGRAPHY BY AIR LAND SURVEYS, INC.(4/24/00) SCANNED FROM CDM DRAWING DETSVR/DETL007770/C:/PROJ/28963/_GIS/OU1/OU1_REPORT.APR REVISED 11/10/02. PORTAGE CREEK OUTLINE NORTH OF THE ALLIED PROPERTY UPDATED ON 12/4/02 USING A CDM CREEK OUTLINE PREPARED ON 9/23/02 PROVIDED ON COMPACT DISK.
6. PERFORMANCE PAPER, STREBOR AND PANELYTE SITE MONITORING WELLS SURVEY BY PREIN AND NEWHOF (6/2009).
7. MONITORING WELLS SHADED GRAY NOT USED TO GENERATE GROUNDWATER CONTOURS.
8. MONITORING WELLS MW-6, MW-7, MW-8A, MW-125A AND MW-126AR ARE NOT TRUE WATER TABLE WELLS (i.e., THE WATER TABLE IS NOT WITHIN THE SCREENED INTERVAL), RATHER THEY ARE SCREENED SLIGHTLY BELOW THE WATER TABLE. DATA FROM THESE WELLS WERE JUDGED TO REPRESENT A REASONABLE APPROXIMATION OF THE WATER TABLE AND AS SUCH WERE USED TO GUIDE CONTOURING IN AREAS OF SPARSE DATA.

LEGEND:

		EDGE OF WATER OR DRAINAGE CHANNEL
		SHEETPILE LOCATION
		SURVEYED PROPERTY BOUNDARY
		APPROXIMATE PROPERTY BOUNDARY
		TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
		RAILROAD TRACK
		ROAD/TRAIL
ALLIED OU	MW-26	MONITORING WELL
	OW-12A	PIEZOMETER LOCATION
	GWE-1A	RECOVERY WELL LOCATION
PANELYTE	MW1	MONITORING WELL INSTALLED BY PANELYTE
STREBOR	MW-1	STREBOR WELL LOCATION
PERFORMANCE PAPER	MW-16S	MONITORING WELL (ECT-2005)
	MW-4	MONITORING WELL (ATLANTIC TESTING-1990)
	SG-2	EXISTING SURFACE WATER STAFF GAUGE
	•	STANDING WATER ELEVATION (FEET)
	795.7	GROUNDWATER ELEVATION (IN FEET)
	798	GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)

0 400' 800'

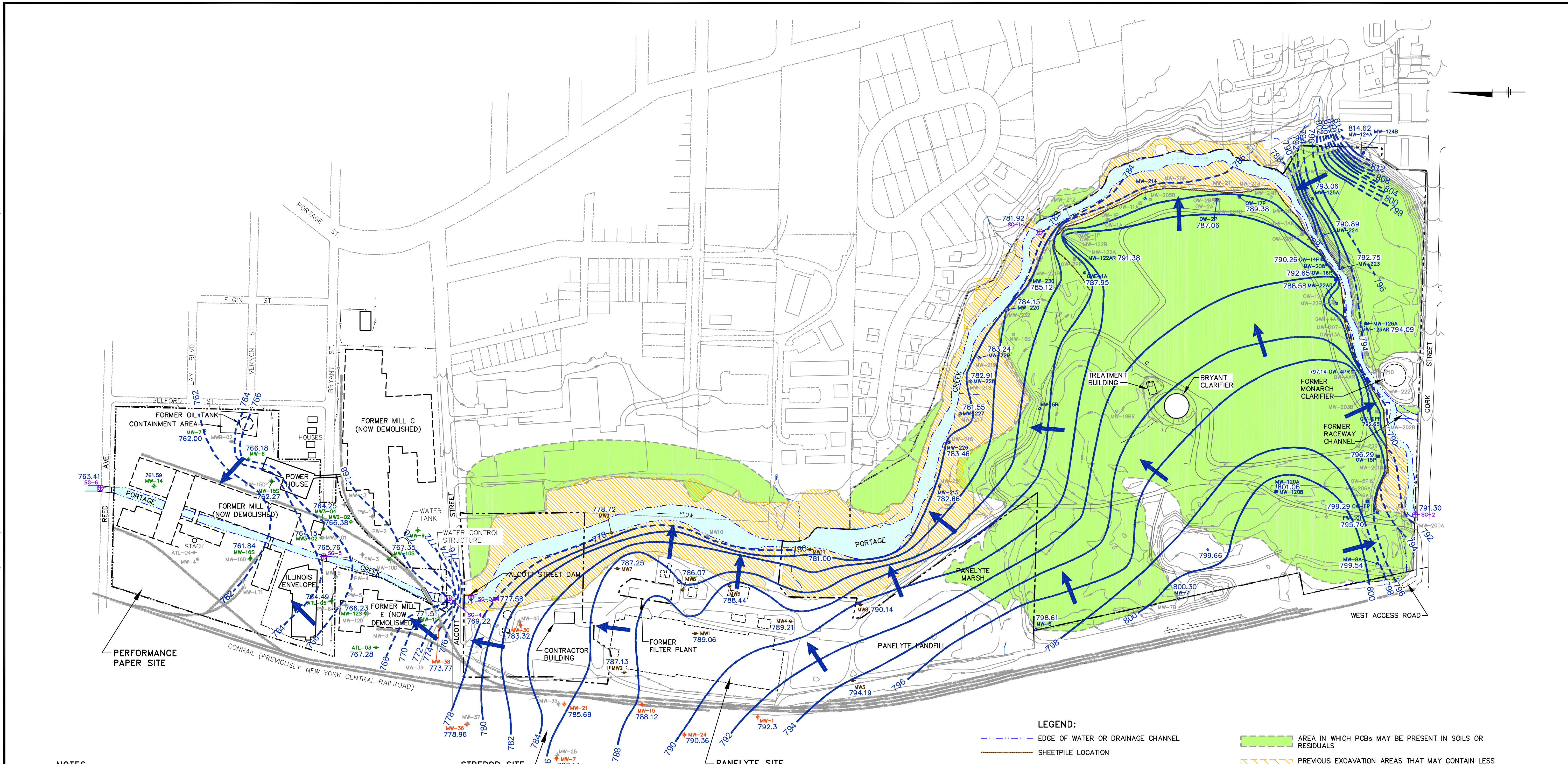
GRAPHIC SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

WATER TABLE CONTOUR MAP
JUNE 25 - 26, 2009

ARCADIS

FIGURE
3-1



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9. THE LIMITS OF THE USEPA EXCAVATION WERE COPIED FROM FIGURE 4-2 OF THE ALLIED PAPER/PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE FINAL REPORT, PREPARED BY WESTON, JANUARY 2000; HOWEVER, THE SURVEYED EXCAVATION BOUNDARY PROVIDED BY THE USEPA HAS BEEN MODIFIED BASED ON FIELD OBSERVATIONS TO MORE ACCURATELY REFLECT SITE CONDITIONS.
10. FIGURE BASED ON FIGURE 35A FROM 2003 RI REMEDIAL INVESTIGATION REPORT (BBL, 2003).

LEGEND:

- EDGE OF WATER OR DRAINAGE CHANNEL
- SHEETPILE LOCATION
- SURVEYED PROPERTY BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY
- TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
- RAILROAD TRACK
- ROAD/TRAIL
- ALLIED OU: MW-26 MONITORING WELL; OW-12A PIEZOMETER LOCATION; CWE-1A RECOVERY WELL LOCATION
- PANELYTE: MW1 MONITORING WELL INSTALLED BY PANELYTE
- STREBOR: MW-1 STREBOR WELL LOCATION
- PERFORMANCE PAPER: MW-16S MONITORING WELL (ECT-2005); MW-4 MONITORING WELL (ATLANTIC TESTING-1990)
- SG-2 EXISTING SURFACE WATER STAFF GAUGE
- STANDING WATER ELEVATION (FEET)
- 795.7 GROUNDWATER ELEVATION (IN FEET) (6/25/09-6/26/09)
- 798 GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)
- AREA IN WHICH PCBs MAY BE PRESENT IN SOILS OR RESIDUALS
- PREVIOUS EXCAVATION AREAS THAT MAY CONTAIN LESS THAN 1 ppm PCB UNDERNEATH 1 TO 10 FEET CLEAN FILL

0 400' 800'

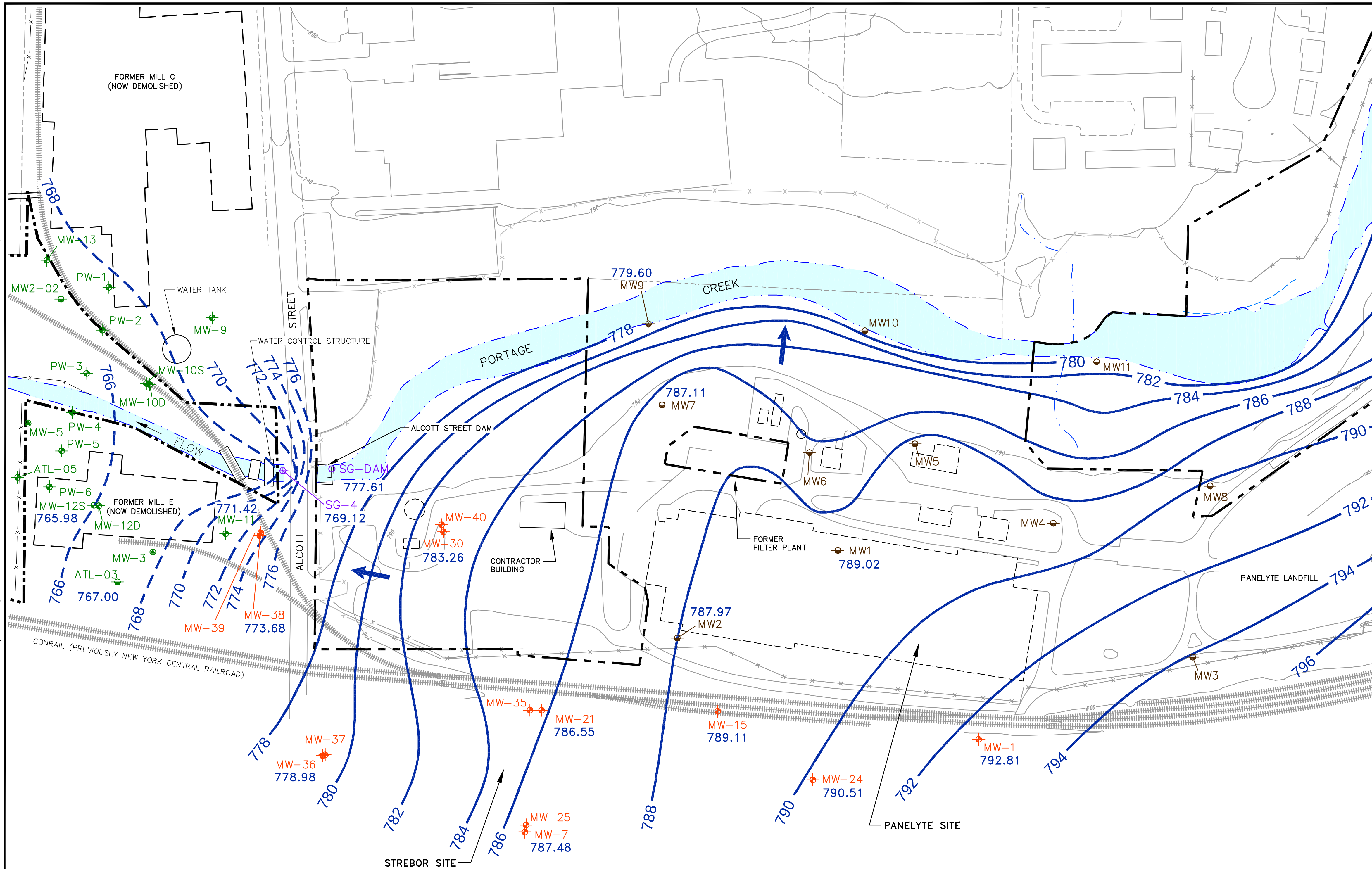
GRAPHIC SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

WATER TABLE CONTOUR MAP - JUNE 25 - 26, 2009 AND POTENTIAL EXTENT OF RESIDUALS

ARCADIS

FIGURE 3-2



LEGEND:

EDGE OF WATER OR DRAINAGE CHANNEL

SURVEYED PROPERTY BOUNDARY

APPROXIMATE PROPERTY BOUNDARY

810 TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)

RAILROAD TRACK

ROAD/TRAIL

PANELYTE — MW1 — MONITORING WELL INSTALLED BY PANELYTE

STREBOR — MW-1 — STREBOR WELL LOCATION

PERFORMANCE PAPER — MW-16S — MONITORING WELL (ECT-2005)

MW-4 — MONITORING WELL (ATLANTIC TESTING-1990)

SG-4 — EXISTING SURFACE WATER STAFF GAUGE

795.7 — GROUNDWATER ELEVATION (IN FEET)

798 — GROUNDWATER ELEVATION CONTOUR

0 200' 400'

GRAPHIC SCALE

NOTES:

1. TOPOGRAPHIC MAPPING NORTH OF FORMER TYPE III LANDFILL AREA, AND BRYANT HRDLs/FRDLs PRODUCED USING PHOTOGRAMETRIC METHODS BY LOCKWOOD, INC. FROM AERIAL PHOTOGRAPHY FLOWN MAY 1991. BASE MAP INFORMATION WITHIN FORMER TYPE III LANDFILL AREA AND AREA NORTH OF WESTERN DISPOSAL AREA FIELD SURVEY OBTAINED FROM PLAN ENTITLED "TOPOGRAPHIC AND BOUNDARY SURVEY OF ALLIED PAPER, INC. KALAMAZOO, MI. SECTION 27. TOWN 2 SOUTH, RANGE 11 WEST," PREPARED BY WADE–TRIM, INC., DATED 7/8/99. BASE MAP INFORMATION WITHIN BRYANT HRDLs/FRDLs AREA OBTAINED FROM PLAN ENTITLED "AS BUILT SURVEY OF ALLIED PAPER SITE" PREPARED BY PREIN AND NEWHOF, KALAMAZOO, MI. DATED 1/27/05 (PROJECT NO. 2000171K). TOPOGRAPHIC CONTOUR LINES INSIDE THE MONARCH HRDL AREA SURVEYED BY PREIN & NEWHOF SURVEYORS ON 4/03. NGVD 1929. BASE MAP INFORMATION IN THE WESTERN DISPOSAL AREA BASED ON TOPOGRAPHIC SURVEY PERFORMED BY PREIN & NEWHOF, DRAWING FILE NUMBER 2060643K, DATED SEPTEMBER 27, 2006. BASE MAP INFORMATION AND PERFORMANCE PAPER WELL LOCATIONS BY MACTEC (2002), AND ATLANTIC TESTING (1990) NORTH OF ALCOTT STREET PREPARED BY DIGITIZING A PAPER COPY OF A PDF OF A DRAWING MADE BY "FISHBECK, THOMPSON, CARR & HUBER ENGINEERS–SCIENTISTS–ARCHITECTS" TITLED BASELINE ENVIRONMENTAL ASSESSMENT–SITE PLAN PROJECT NUMBER G03561A, DATED 2005, AT A SCALE OF 1"=150'. PERFORMANCE PAPER WELL LOCATIONS BY "ENVIRONMENTAL CONSULTING & TECHNOLOGY, INC." (ECT), DIGITIZED FROM PAPER COPY OF A PDF OF A DRAWING MADE BY "ECT" TITLED "SITE MAP WITH SAMPLING LOCATIONS – FIGURE 4", DATED 2005, AT A SCALE OF 1"=200'.
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6. PERFORMANCE PAPER, STREBOR AND PANELYTE SITE MONITORING WELLS SURVEY BY PREIN AND NEWHOF (6/2009).
7. GROUNDWATER ELEVATIONS WERE COLLECTED DURING A SHUTDOWN PERIOD OF THE STREBOR GROUNDWATER EXTRACTION SYSTEM.

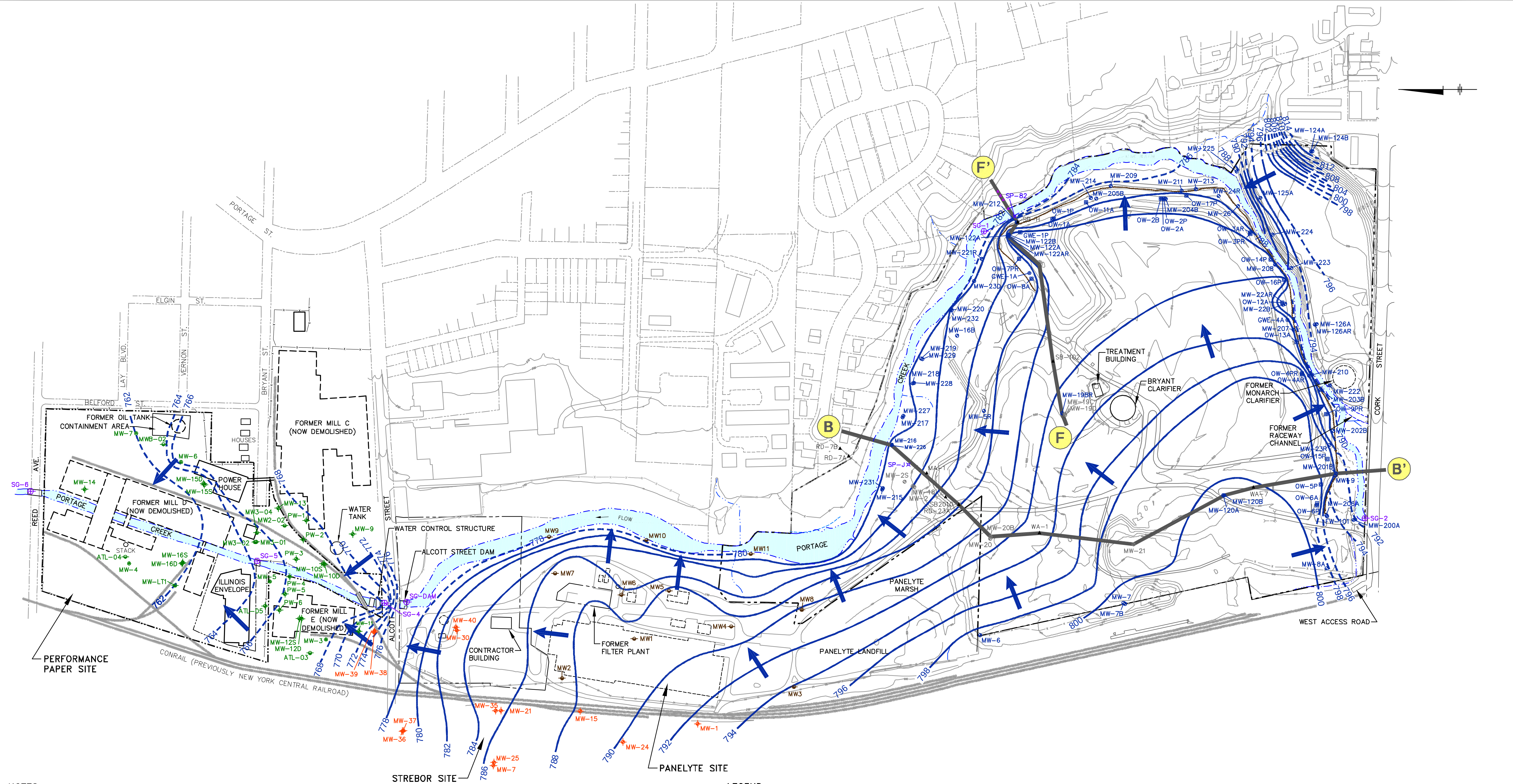
MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK /
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

WATER TABLE CONTOUR MAP
JULY 2, 2009

ARCADIS

FIGURE
3-3

CITY: SYRACUSE, NY GROUP: ENVCAD DB: R.ALLEN, P. LISTER TR: J. ROBERTSON LYR:ON=*;OFF=REF* (FRZ) ACADVER: 17.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/3/2009 1:50 PM BY: JONES, WENDY
G:\ENVCAD\SYRACUSE\ACT\B0064587\0001\00004\DWG\64587W03.DWG LAYOUT: 3-3 SAVED: 9/2/2009 3:12 PM
XREFS: 64587X11 64587XDL IMAGES: PROJECTNAME: ----



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6. PERFORMANCE PAPER, STREBOR AND PANELYTE SITE MONITORING WELLS SURVEY BY PREIN AND NEWHOF (6/2009).

LEGEND:

EDGE OF WATER OR DRAINAGE CHANNEL
SHEETPILE LOCATION
SURVEYED PROPERTY BOUNDARY
APPROXIMATE PROPERTY BOUNDARY
TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
RAILROAD TRACK
ROAD/TRAIL

ALLIED OU
- MW-26 MONITORING WELL
- OW-12A PIEZOMETER LOCATION
- GWE-1A RECOVERY WELL LOCATION

PANELYTE
- MW1 MONITORING WELL INSTALLED BY PANELYTE

STREBOR
- MW-1 STREBOR WELL LOCATION

PERFORMANCE PAPER
- MW-16S MONITORING WELL (ECT-2005)
- MW-4 MONITORING WELL (ATLANTIC TESTING-1990)

SG-2 EXISTING SURFACE WATER STAFF GAUGE

798 WATER TABLE ELEVATION CONTOUR (DASHED WHERE INFERED) JUNE 25 – 26, 2009

F — F' FLOW NET LOCATION

0 400' 800'

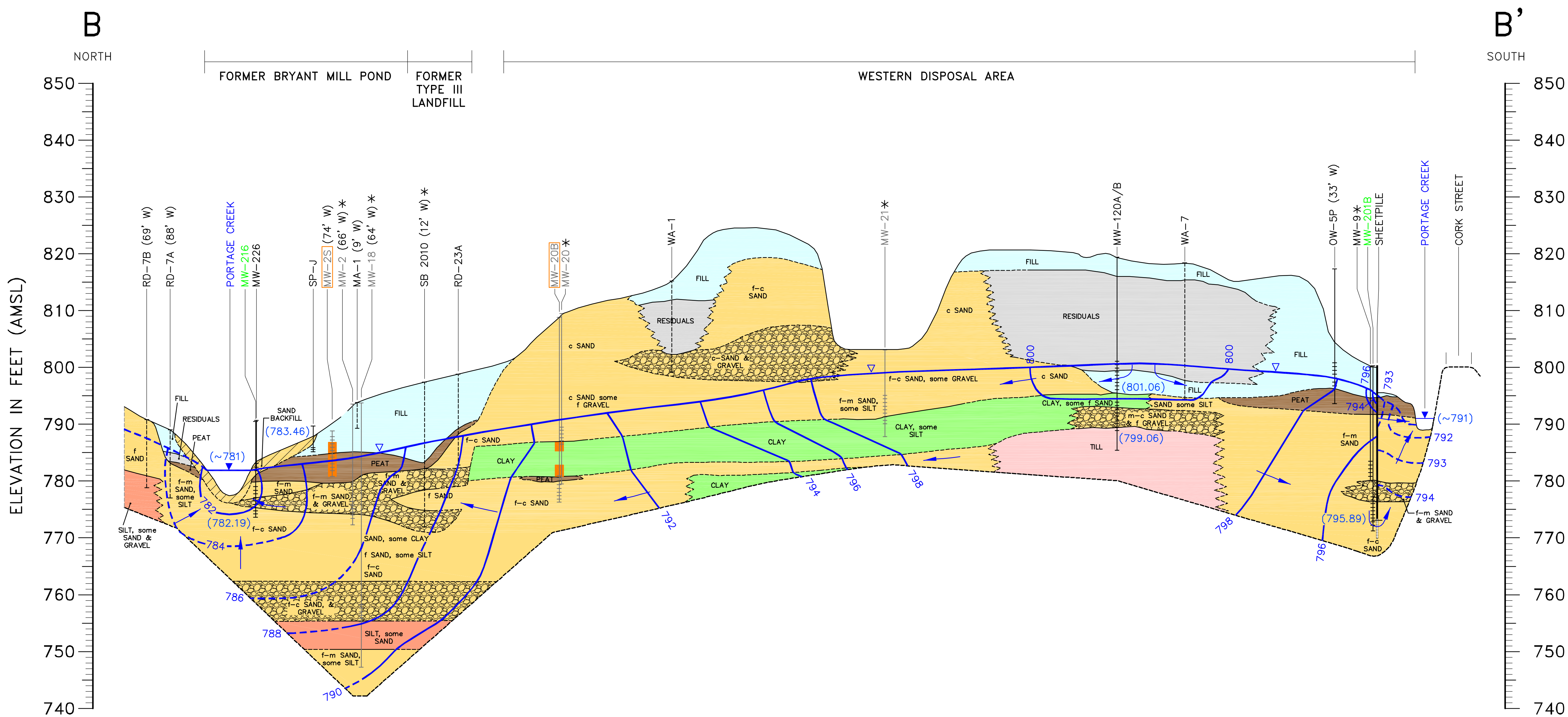
GRAPHIC SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GROUNDWATER FLOW NET CROSS SECTION LOCATION MAP

ARCADIS

FIGURE
3-4



LEGEND:

MW-10 SOIL BORING/SINGLE-CASED WELL

MW-205B DOUBLE-CASED WELL

MW-2S BORING/WELL LOCATION WITH GEOTECHNICAL SAMPLE(S) COLLECTED AND ANALYZED

GV-09 GAS VENT

* NOT CONTINUOUSLY SAMPLED. SAMPLED AT 5 FOOT INTERVALS.

(11' E) DISTANCE AND DIRECTION FROM WHICH BORING/WELL IS PROJECTED ONTO SECTION LINE (IF GREATER THAN 10 FEET)

MW-1 BORING/WELL ID

APPROXIMATE SURFACE WATER ELEVATION

WATER TABLE 6/25-26/09 (DASHED WHERE INFERRED)

GAS VENT

PERMANENT SUMP

SHEET PILE (SEE NOTE 6)

SOIL BORING

ABANDONED MONITORING WELL

MONITORING WELL

GEOTECHNICAL SAMPLE INTERVAL

SCREENED INTERVAL

(782.19) GROUNDWATER ELEVATION 6/25 – 26/09

BOTTOM OF BORING

FILL: CONSISTS CHIEFLY OF A HETEROGENEOUS MIXTURE OF SAND AND SILT WITH VARIABLE AMOUNTS OF GRAVEL AND OCCASIONAL DISCONTINUOUS INTERVALS OF REWORKED PEAT. MAY CONTAIN TRACE AMOUNTS OF RESIDUALS.

SAND BACKFILL: EXTENT (VERTICAL & HORIZONTAL) OF SAND BACKFILL PLACED FOLLOWING THE USEPA'S REMOVAL ACTION AT THE FORMER BRYANT MILL POND IS BASED ON A REVIEW OF THE FINAL REPORT (WESTON, 2000). TOTAL DEPTH OF EXCAVATION WAS NOT PROVIDED WITHIN THE REPORT.

RESIDUALS: RESIDUALS MAY CONTAIN THIN LAYERS OF SAND OR OTHER FILL.

PEAT: DEPOSITS OF POST-GLACIAL AGE CONSISTING OF PEAT OR ORGANIC-RICH SILT OR CLAY.

SAND: PREDOMINANT GRAIN SIZE OF SAND SHOWN AS FINE [f], MEDIUM [m], OR COARSE [c]. MAY CONTAIN SMALL AMOUNTS OF CLAY, SILT, OR GRAVEL.

GRAVEL: GRAVEL MAY CONTAIN SMALL AMOUNTS OF f-c SAND, SILT AND CLAY.

CLAY: CLAY MAY CONTAIN SMALL AMOUNTS OF f-c SAND AND SILT.

SILT: SILT MAY CONTAIN SMALL AMOUNTS OF f-c SAND AND CLAY.

TILL: A GENERALLY HARD DEPOSIT WITH LITTLE OR NO SORTING AND CONSISTING CHIEFLY OF f SAND, SILT, AND/OR CLAY IN VARYING PROPORTIONS, WITH LESSER AMOUNTS OF m-c SAND AND GRAVEL. MAY CONTAIN OCCASIONAL, DISCONTINUOUS LENSES OF SILT, SAND, AND/OR GRAVEL.

NOTES:

1. SURFACE-WATER ELEVATIONS ARE APPROXIMATE AND ARE BASED ON INTERPOLATION BETWEEN GAUGES.
2. DASHED LINES BETWEEN UNITS REPRESENT INFERRED BOUNDARIES.
3. SURFACE ELEVATIONS FROM TOPOGRAPHIC MAPPING BY LOCKWOOD MAPPING, INC., AND MONITORING WELL/BORING SURVEY DATA.
4. AMSL = ABOVE MEAN SEA LEVEL (NGVD OF 1929).
5. THE DASHED PORTION OF THE SHEET PILE ILLUSTRATES THE HIGHEST AND LOWEST DRIVEN DEPTH OF THE PILING WITHIN 20 FT. OF EITHER SIDE OF THE LINE OF SECTION. THE HORIZONTAL LINE DEPICTS THE DRIVEN DEPTH OF THE SHEET PILE ALONG THE LINE OF SECTION.
6. REFRACTION ANGLES OF EQUIPOTENTIAL LINES ARE APPROXIMATE. THE FLOW NET AS ILLUSTRATED IS CONCEPTUAL AND CONSISTENT WITH AVAILABLE DATA.

10' 0 10' 20'
VERTICAL SCALE

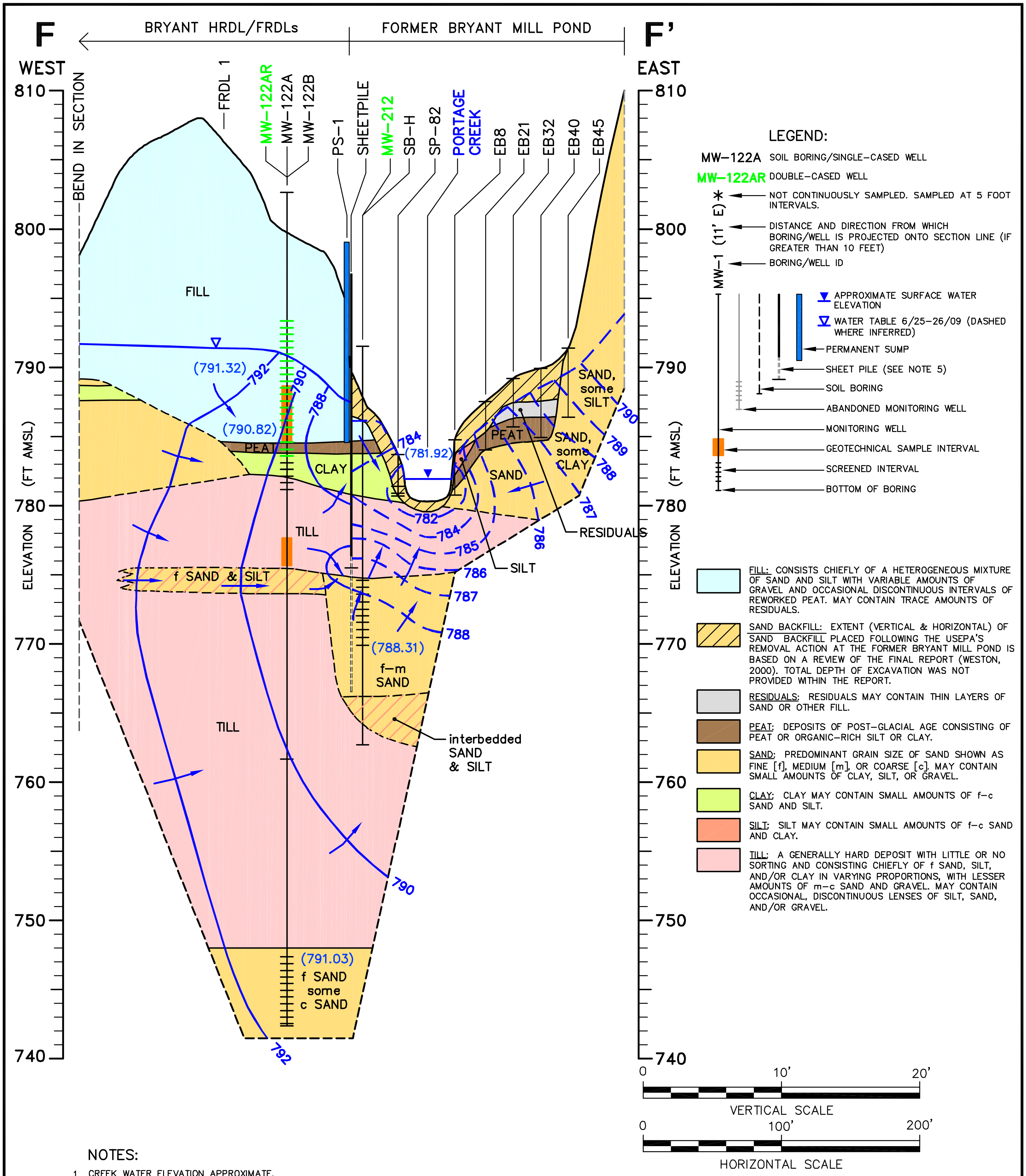
100' 0 100' 200'
HORIZONTAL SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GEOLOGIC CROSS SECTION B-B'
GROUNDWATER FLOW NET
JUNE 25-26, 2009

ARCADIS

FIGURE
3-5



NOTES:

1. CREEK WATER ELEVATION APPROXIMATE.
2. DASHED LINES BETWEEN UNITS REPRESENT INFERRED BOUNDARIES.
3. SURFACE ELEVATIONS FROM TOPOGRAPHIC MAPPING BY LOCKWOOD MAPPING, INC., AND MONITORING WELL/BORING SURVEY DATA. GROUND SURFACE UPDATED BASED ON SURVEYS BY WADE TRIM, DATED 7/8/99, AND PREIN AND NEWHOF, DATED 1/27/05.
4. AMSL = ABOVE MEAN SEA LEVEL (NGVD OF 1929).
5. THE DASHED PORTION OF THE SHEET PILE ILLUSTRATES THE HIGHEST AND LOWEST DRIVEN DEPTH OF THE PILING WITHIN 20 FT. OF EITHER SIDE OF THE LINE OF SECTION. THE HORIZONTAL LINE DEPICTS THE DRIVEN DEPTH OF THE SHEET PILE ALONG THE LINE OF SECTION.
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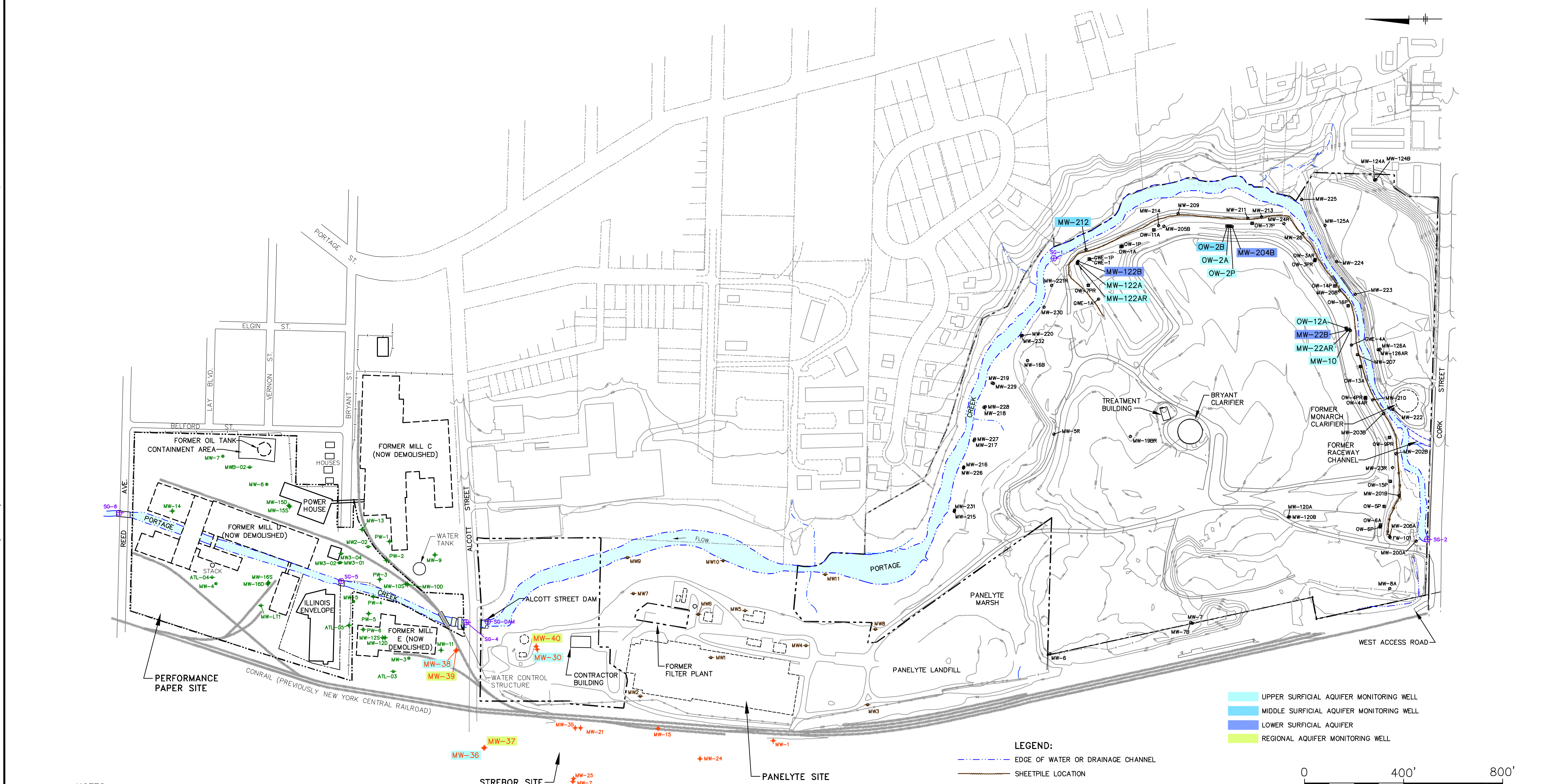
MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK /
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GEOLOGIC CROSS SECTION F-F'
GROUNDWATER FLOW NET
JUNE 25 - 26, 2009

ARCADIS

FIGURE
3-6



LEGEND:

- EDGE OF WATER OR DRAINAGE CHANNEL
- SHEETPILE LOCATION
- SURVEYED PROPERTY BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY
- TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
- RAILROAD TRACK
- ROAD/TRAIL

ALLIED OU
- MW-26 SINGLE-CASED MONITORING WELL OR CLUSTER
- MW-203B DOUBLE-CASED MONITORING WELL
- OW-12A PIEZOMETER LOCATION
- GWE-1A RECOVERY WELL LOCATION

PANELYTE
- MW1 MONITORING WELL INSTALLED BY PANELYTE

STREBOR
- MW-1 STREBOR WELL LOCATION

PERFORMANCE PAPER
- MW-16S MONITORING WELL (ECT-2005)
- MW-4 MONITORING WELL (ATLANTIC TESTING-1990)

- SG-2 EXISTING SURFACE WATER STAFF GAUGE

NOTES:

1. TOPOGRAPHIC MAPPING NORTH OF FORMER TYPE III LANDFILL AREA, AND BRYANT HRDLs/FRDLs PRODUCED USING PHOTOGRAMETRIC METHODS BY LOCKWOOD, INC. FROM AERIAL PHOTOGRAPHY FLOWN MAY 1991. BASE MAP INFORMATION WITHIN FORMER TYPE III LANDFILL AREA AND AREA NORTH OF WESTERN DISPOSAL AREA FIELD SURVEY OBTAINED FROM PLAN ENTITLED "TOPOGRAPHIC AND BOUNDARY SURVEY OF ALLIED PAPER, INC. KALAMAZOO, MI. SECTION 27. TOWN 2 SOUTH, RANGE 11 WEST," PREPARED BY WADE-TRIM, INC., DATED 7/8/99. BASE MAP INFORMATION WITHIN BRYANT HRDLs/FRDLs AREA OBTAINED FROM PLAN ENTITLED "AS BUILT SURVEY OF ALLIED PAPER SITE" PREPARED BY PREIN AND NEWHOF, KALAMAZOO, MI. DATED 1/27/05 (PROJECT NO. 2000171K). TOPOGRAPHIC CONTOUR LINES INSIDE THE MONARCH HRDL AREA SURVEYED BY PREIN & NEWHOF SURVEYORS ON 4/03. NGVD 1929. BASE MAP INFORMATION IN THE WESTERN DISPOSAL AREA BASED ON TOPOGRAPHIC SURVEY PERFORMED BY PREIN & NEWHOF, DRAWING FILE NUMBER 2060643K, DATED SEPTEMBER 27, 2006. BASE MAP INFORMATION AND PERFORMANCE PAPER WELL LOCATIONS BY MACTEC (2002), AND ATLANTIC TESTING (1990) NORTH OF ALCOTT STREET PREPARED BY DIGITIZING A PAPER COPY OF A PDF OF A DRAWING MADE BY "FISHBECK, THOMPSON, CARR & HUBER ENGINEERS-SCIENTISTS-ARCHITECTS" TITLED BASELINE ENVIRONMENTAL ASSESSMENT-SITE PLAN PROJECT NUMBER G03561A, DATED 2005, AT A SCALE OF 1"=150'. PERFORMANCE PAPER WELL LOCATIONS BY "ENVIRONMENTAL CONSULTING & TECHNOLOGY, INC." (ECT), DIGITIZED FROM PAPER COPY OF A PDF OF A DRAWING MADE BY "ECT" TITLED "SITE MAP WITH SAMPLING LOCATIONS – FIGURE 4", DATED 2005, AT A SCALE OF 1"=200'.
2. ELEVATIONS ARE REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) 1929.
3. COORDINATE GRID IS REFERENCED TO THE MICHIGAN STATE PLANE (SOUTH ZONE) COORDINATE SYSTEM (NAD83).
4. ALLIED PROPERTY LINES ESTABLISHED USING: WADE-TRIM SURVEY (9/1999)-NORTHERN PARCEL ONLY; ATWELL HICKS, INC. SURVEY (11/2002); AND PREIN AND NEWHOF SURVEY (12/2002).
5. PORTAGE CREEK OUTLINE WITHIN THE ALLIED PROPERTY UPDATED ON 12/4/02 USING DIGITAL ORTHOGRAPHY BY AIR LAND SURVEYS, INC.(4/24/00) SCANNED FROM CDM DRAWING DETSVR/DETL007770/C:/PROJ/28963/_GIS/OU1/OU1_REPORT.APR REVISED 11/10/02. PORTAGE CREEK OUTLINE NORTH OF THE ALLIED PROPERTY UPDATED ON 12/4/02 USING A CDM CREEK OUTLINE PREPARED ON 9/23/02 PROVIDED ON COMPACT DISK.
6. PERFORMANCE PAPER, STREBOR AND PANELYTE SITE MONITORING WELLS SURVEY BY PREIN AND NEWHOF (6/2009).
7. MW-204B COULD POTENTIALLY BE SCREENED AT THE TOP OF THE REGIONAL AQUIFER, HOWEVER SITE BORING DATA ARE NOT EXTENSIVE ENOUGH AT DEPTH TO CONFIRM THIS.

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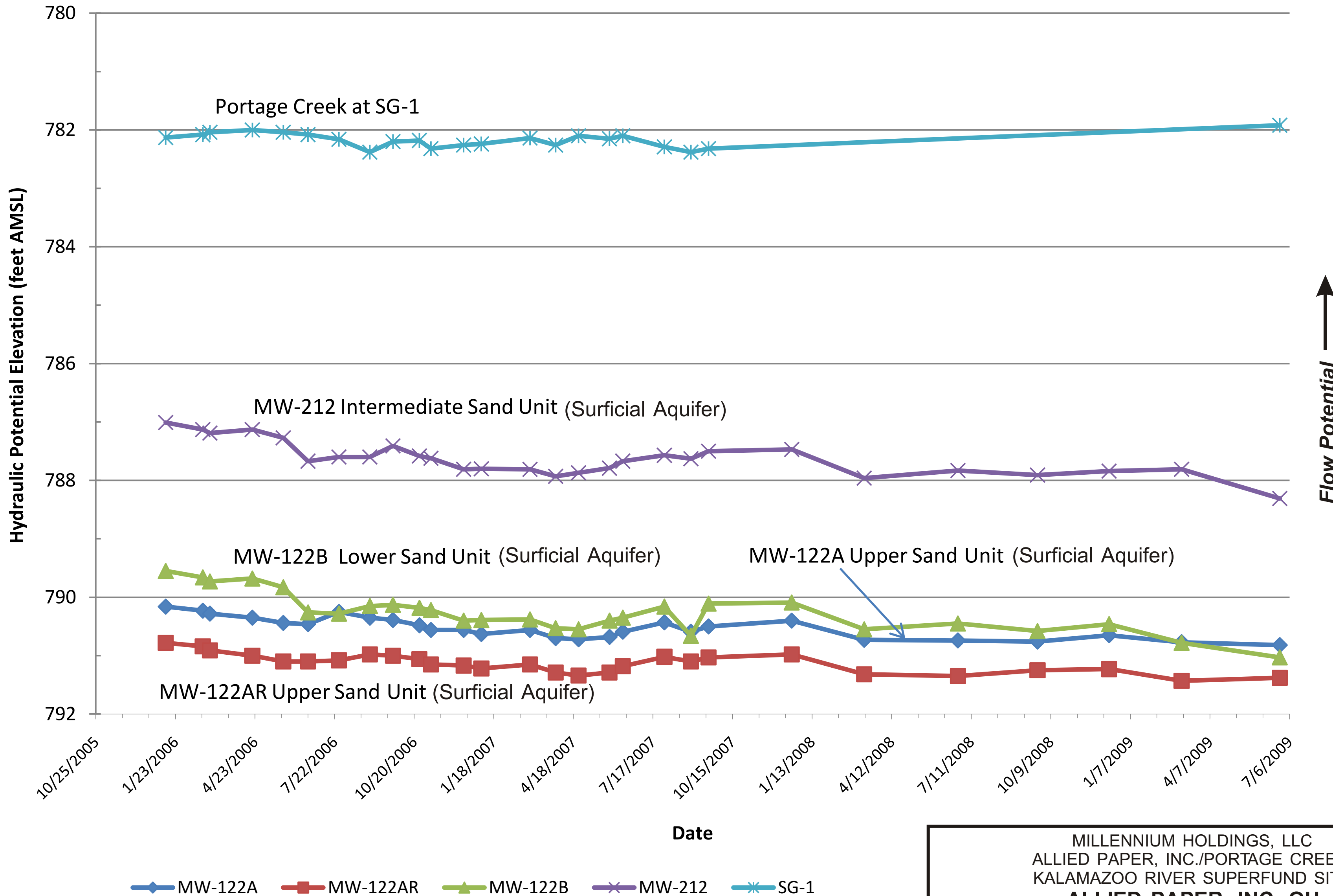
ALLIED PAPER, INC. OU

WELL CLUSTER LOCATION MAP

ARCADIS

FIGURE
3-7

09/30/09 SYRACUSE-141ENV-DJHOWES
B0064587/0001/00003/CDR/64587G05.CDR



The data show a downward flow potential from the upper sand unit to the intermediate sand unit and an upward flow potential from the lower sand unit to the intermediate sand. Portage Creek is at the lowest elevation, and serves as the discharge point for groundwater present in the upper, intermediate, and lower sand units.

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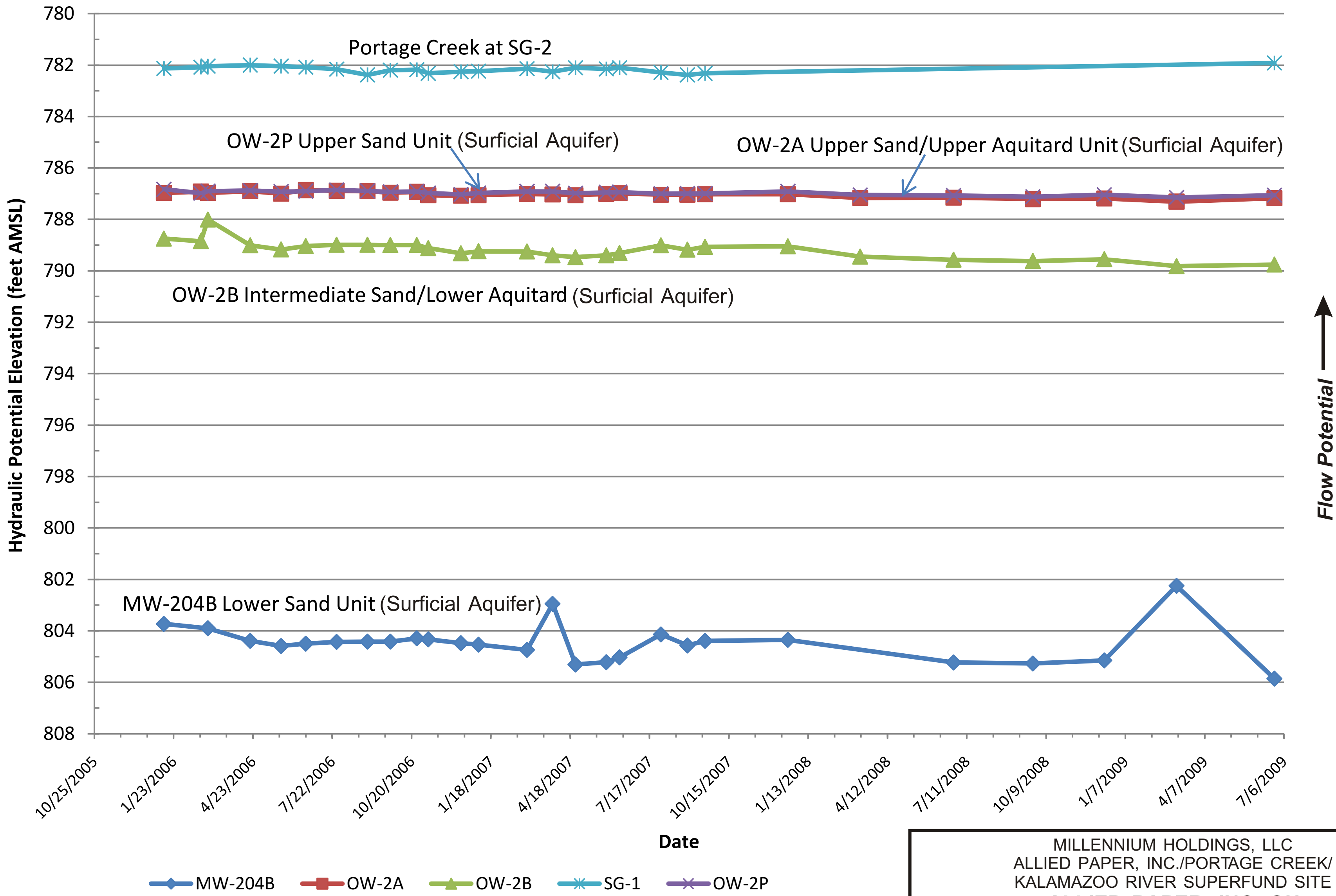
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

ALLIED OU - MW-122/MW-212
WELL CLUSTER GROUNDWATER
ELEVATIONS 2006 - 2009

ARCADIS

FIGURE
3-8



The data show a strong upward flow potential from the lower sand unit to the intermediate and upper sand units. Portage Creek is at the lowest elevation and serves as the discharge point for groundwater present in the upper, intermediate, and lower sand units.

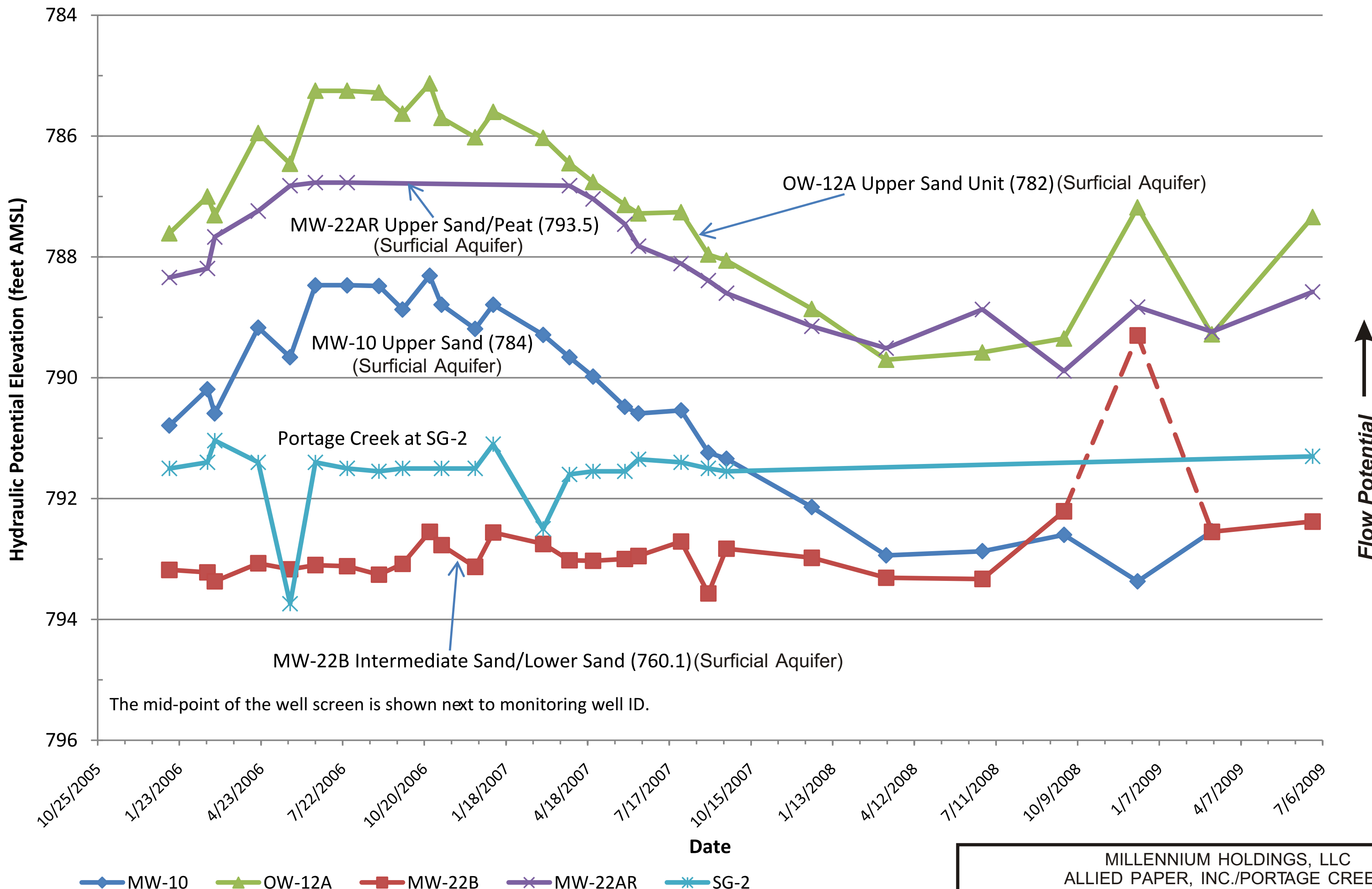
MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

**ALLIED OU - MW-204/OW-2
WELL CLUSTER GROUNDWATER
ELEVATIONS 2006 - 2009**

ARCADIS

FIGURE
3-9

09/08/09 SYRACUSE-141ENV-DJHOWES
B0064587/0001/00003/CDR/64587G07.CDR



The data show an upward[1] flow potential from the intermediate/lower sand unit to the upper sand unit and Portage Creek. The lower groundwater elevations observed in the upper sand are due to the pumping of groundwater from behind the sheet pile wall from nearby extraction well GWE-4A.

NOTE:

[1] The December 2008 elevation measurement at MW-22B is anomalous, varying by over 3.6 feet from the average of the elevations measured from 2006 to the present.

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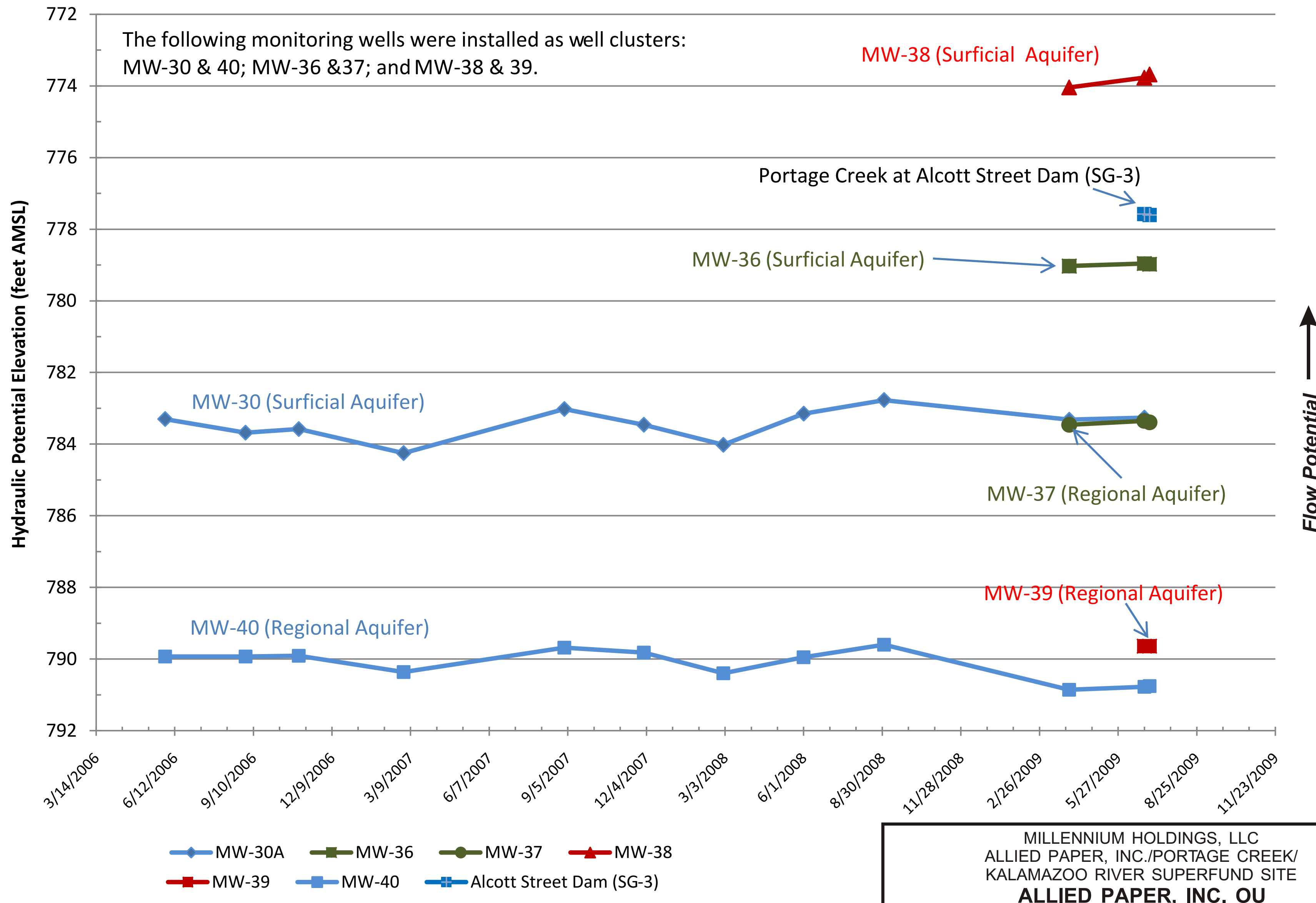
ALLIED PAPER, INC. OU

ALLIED OU - MW-22/MW-10 WELL CLUSTER GROUNDWATER ELEVATIONS 2006 - 2009

ARCADIS

FIGURE
3-10



Data for each well cluster, consisting of a well in the surficial aquifer and a well in the regional aquifer, show a strong upward flow potential between the two aquifer systems.

MILLENNIUM HOLDINGS, LLC
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ALLIED PAPER, INC. OU

STREBOR PROPERTY MONITORING WELL CLUSTER GROUNDWATER ELEVATIONS 2006 - 2009

ARCADIS

FIGURE
3-11

ARCADIS

Attachment A

Historical Groundwater and
Surface Water Elevation Data

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table A-1 -- Allied OU - Historical Groundwater and Portage Creek Elevation Monitoring Data, 2006 - 2009

Location	Groundwater Elevation in feet AMSL														
	1/12/2006	2/23/2006	3/3/2006	4/20/2006	5/25/2006	6/22/2006	7/27/2006	8/31/2006	9/26/2006	10/26/2006	11/8/2006	12/15/2006	1/4/2007	2/28/2007	3/29/2007
FW-101	796.56	796.64	796.56	796.35	796.31	795.63	795.44	795.75	796.19	796.70	796.75	800.36	796.76	796.65	796.61
GWE-1	788.05	788.17	788.27	788.27	788.54	788.41	788.36	788.53	788.31	788.32	788.43	788.56	788.57	788.42	788.67
GWE-1A	783.30	781.80	783.06	782.91	780.83	785.73	784.97	783.37	784.98	786.13	786.23	786.05	783.41	783.79	780.11
GWE-1P	788.07	788.14	788.28	788.29	788.35	788.40	788.37	788.27	788.29	788.29	788.42	788.55	788.57	788.40	788.65
GWE-4A	788.35	783.05	786.94	781.41	781.11	779.28	781.14	781.23	781.81	780.41	780.45	779.41	779.76	780.18	779.01
MW-5R	792.64	792.82	792.86	792.74	792.87	792.60	792.42	792.45	792.65	792.85	792.80	793.06	793.02	792.86	793.17
MW-6	797.74	797.85	797.90	797.86	798.02	797.79	797.67	797.78	797.80	797.96	797.74	798.21	798.05	797.97	798.28
MW-7	799.39	799.55	799.62	799.53	799.72	799.44	799.26	799.39	799.42	799.60	799.41	799.91	799.72	799.67	799.99
MW-8A	799.12	799.13	799.21	799.18	799.27	799.06	799.01	799.18	799.21	799.24	799.21	799.42	799.37	799.37	799.47
MW-16B	786.37	786.70	786.87	786.76	786.98	786.80	786.66	786.67	786.61	786.76	786.77	787.03	787.20	787.09	787.51
MW-19BR	794.96	795.39	795.69	795.59	795.78	795.55	795.18	794.99	795.20	795.43	795.50	795.93	796.04	795.79	796.27
MW-22AR	788.34	788.19	787.67	787.24	786.82	786.77	786.77	Dry	Dry	Dry	Dry	Dry	Dry	Dry	786.82
MW-22B	793.18	793.22	793.37	793.07	793.17	793.10	793.12	793.26	793.08	792.55	792.77	793.13	792.56	792.75	793.02
MW-23AR	795.71	795.74	795.81	795.78	795.90	795.81	795.81	795.89	795.86	795.67	795.70	795.93	795.87	795.94	796.07
MW-24R	788.53	788.47	788.39	788.33	788.39	788.32	788.40	788.43	788.41	788.39	788.50	788.58	788.50	788.49	789.17
MW-26	787.86	787.87	787.89	787.91	787.75	787.70	787.67	787.87	787.65	787.78	787.74	787.92	787.65	787.67	787.65
MW-120A	800.88	801.51	801.41	801.19	801.22	800.84	800.28	800.06	800.50	800.96	801.16	801.24	801.34	800.79	801.22
MW-120B	798.52	798.61	798.42	798.57	798.80	798.40	798.25	798.33	798.46	798.28	798.58	798.90	798.86	798.65	798.97
MW-122A	790.16	790.23	790.28	790.35	790.44	790.46	790.25	790.35	790.39	790.48	790.56	790.56	790.63	790.56	790.70
MW-122AR	790.78	790.84	790.91	791.00	791.10	791.10	791.08	790.98	791.00	791.06	791.15	791.17	791.22	791.15	791.29
MW-122B	789.55	789.66	789.73	789.68	789.83	790.26	790.28	790.15	790.13	790.18	790.22	790.40	790.39	790.38	790.53
MW-124A	808.32	809.11	810.52	810.85	810.94	812.46	812.12	811.55	811.87	811.74	811.73	812.17	812.42	813.42	813.61
MW-124B	801.88	802.09	802.63	802.69	802.87	802.78	802.71	802.71	802.62	802.55	802.65	803.08	802.61	802.92	803.25
MW-125A	792.60	792.61	792.32	792.36	792.48	791.73	791.70	791.44	792.27	792.83	792.44	793.53	792.42	793.32	792.83
MW-126A	796.26	796.57	796.47	796.35	796.28	795.93	795.78	795.99	795.11	794.70	795.96	796.07	795.55	795.59	795.86
MW-126AR	794.56	794.60	794.68	794.50	794.61	794.49	794.50	794.61	795.89	795.45	794.10	794.34	794.06	794.19	794.40
MW-200A	795.58	795.58	795.63	795.61	795.70	795.63	795.65	795.72	795.69	795.68	795.59	795.77	795.63	795.74	795.86
MW-201B	795.65	795.68	795.74	795.71	795.82	795.75	796.15	795.82	795.78	795.70	795.67	795.89	795.81	795.90	796.00
MW-202B	795.53	795.54	795.60	795.57	795.70	795.62	795.63	795.70	795.68	795.46	795.49	795.72	795.65	795.74	795.87
MW-203B	794.64	794.64	794.68	794.34	794.75	794.69	794.72	794.80	794.74	794.06	794.24	794.44	794.34	794.42	794.55
MW-204B	803.73	NM	803.90	804.39	804.59	804.50	804.43	804.42	804.42	804.29	804.33	804.48	804.54	804.74	802.95
MW-205B	792.19	792.41	792.66	792.65	792.92	792.74	792.54	792.49	792.56	792.62	792.70	793.03	793.01	792.97	793.28
MW-206A	796.08	796.10	796.16	796.78	796.24	796.15	796.14	796.20	796.19	796.15	796.11	796.34	796.28	796.30	796.43
MW-207	795.57	795.60	795.73	794.94	795.61	795.55	795.56	795.67	795.54	794.70	794.97	795.25	794.87	795.30	795.25
MW-208	795.86	795.93	796.13	795.79	795.84	795.81	795.84	796.00	795.74	795.54	795.72	796.12	795.32	795.55	795.84
MW-209	791.25	791.39	791.60	791.62	791.90	791.70	791.55	791.54	791.56	791.61	791.68	792.00	791.95	792.00	792.06
MW-210	794.92	794.92	795.02	794.86	795.00	794.92	794.92	795.02	794.93	793.84	794.13	794.40	794.13	794.30	794.45
MW-211	790.82	790.91	791.06	791.08	791.25	791.15	791.08	791.08	791.06	791.07	791.14	791.35	791.22	791.26	791.41
MW-212	787.01	787.13	787.19	787.13	787.27	787.67	787.60	787.60	787.41	787.58	787.62	787.81	787.80	787.81	787.93
MW-213	790.57	790.66	790.80	790.83	790.98	790.89	790.85	790.88	790.85	790.86	790.93	791.11	790.96	791.02	791.05
MW-214	787.47	787.45	787.52	787.48	787.53	787.19	787.14	787.40	787.45	787.51	787.53	787.69	788.17	787.71	787.76
MW-215	783.42	783.10	783.38	782.88	782.86	782.67	782.59	783.16	783.14	783.33	783.37	783.34	783.34	783.41	783.24
MW-216	781.82	781.85	781.90	781.83	781.96	782.14	782.31	782.36	782.15	782.04	781.96	782.02	782.02	781.92	782.03
MW-217	782.57	782.59	782.61	782.55	782.71	782.86	782.94	782.96	782.76	782.72	782.64	782.78	782.77	782.72	782.82
MW-218	785.20	785.41	785.41	785.35	785.48	785.50	785.44	785.44	785.30	785.32	785.30	785.52	785.55	NM	785.69

See Notes on Page 4.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table A-1 -- Allied OU - Historical Groundwater and Portage Creek Elevation Monitoring Data, 2006 - 2009

Location	Groundwater Elevation in feet AMSL														
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MW-219	784.00	784.07	784.12	784.06	784.18	784.29	784.30	784.34	784.14	784.64	784.10	784.28	784.29	784.81	784.48
MW-220	784.13	785.05	785.13	784.55	784.94	784.88	783.46	783.62	784.11	784.64	784.50	785.39	785.16	784.35	785.18
MW-221R	782.08	782.06	782.00	781.93	782.00	782.02	782.14	782.31	782.16	782.14	782.22	782.19	782.19	782.13	782.21
MW-222	794.23	NM	794.24	794.18	794.33	794.27	794.31	794.38	794.32	793.07	793.36	793.55	793.43	793.32	793.64
MW-223	794.04	793.82	793.90	792.45	792.63	792.73	792.90	793.15	793.10	792.95	793.11	793.51	793.06	NM	NM
MW-224	790.79	792.20	791.45	791.20	792.03	790.48	790.02	790.00	790.47	791.57	791.80	792.72	792.13	790.62	792.36
MW-225	786.08	786.16	786.12	786.04	786.36	785.92	785.86	785.89	786.16	786.40	786.12	786.95	786.57	NM	NM
MW-226	783.59	783.44	783.59	783.58	783.55	783.49	783.50	783.49	783.48	783.57	783.62	783.56	783.59	783.18	783.40
MW-227	782.26	781.84	781.72	781.34	781.61	obstructed	780.65	782.01	781.98	782.23	782.13	782.16	782.08	782.39	781.89
MW-228	783.34	783.23	783.20	782.98	782.99	783.10	782.81	783.16	783.11	783.31	783.37	783.35	783.39	783.40	783.15
MW-229	783.89	783.62	783.72	783.46	783.27	783.03	783.00	783.68	783.65	785.63	783.77	783.78	783.75	783.90	783.63
MW-230	785.52	785.68	785.39	785.14	785.45	784.80	783.97	785.13	785.26	785.59	785.36	785.95	785.56	785.30	785.61
MW-231	786.33	786.54	785.97	786.29	786.39	786.41	786.51	786.57	786.49	786.46	786.36	786.26	786.46	790.66	785.06
MW-232	782.75	782.85	782.87	782.79	782.90	782.80	782.99	783.12	782.92	782.87	782.83	782.99	783.02	782.99	783.15
OW-1A	784.65	784.77	784.92	784.86	785.03	785.26	785.20	785.11	785.13	785.15	785.24	785.91	785.43	785.38	785.58
OW-2A	786.97	786.92	786.97	786.90	787.00	786.86	786.89	786.90	786.96	786.93	787.06	787.08	787.06	787.01	787.03
OW-2B	788.75	788.85	788.01	789.01	789.17	789.04	788.99	788.99	789.00	789.00	789.12	789.32	789.24	789.25	789.40
OW-2P	786.83	786.98	786.90	786.88	786.92	786.90	786.86	786.89	786.93	786.91	786.97	787.03	786.97	786.91	786.91
OW-3AR	787.96	787.95	787.96	787.86	787.93	787.81	787.94	787.96	787.91	787.94	788.05	788.21	787.95	788.54	787.87
OW-3PR	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
OW-4AR	Obstructed	NM	NM	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed
OW-4PR	797.30	797.40	797.43	obstructed	797.45	797.47	797.46	797.39	797.81	797.14	797.29	797.20	797.34	797.27	797.31
OW-5P	796.52	797.19	797.14	796.77	797.49	796.97	796.49	796.33	796.82	797.18	797.21	797.53	797.29	796.62	797.33
OW-6A	795.76	795.78	795.82	795.82	795.91	795.82	795.82	795.87	795.85	795.80	795.77	795.29	795.87	795.97	796.12
OW-6P	798.31	799.07	798.85	798.70	799.87	798.67	797.48	797.17	798.74	799.74	799.45	800.20	799.85	798.80	800.44
OW-7P (OW-7PR)	788.73	788.82	788.92	789.00	789.10	789.11	789.11	789.01	789.03	789.00	789.11	789.13	789.16	789.04	789.19
OW-8A	782.81	782.11	783.28	782.74	783.42	785.46	784.94	783.96	784.80	785.71	785.94	785.64	784.18	785.06	785.69
OW-9PR	792.54	792.48	792.45	792.45	792.55	792.54	792.58	792.61	792.66	792.62	792.67	792.65	792.62	792.49	792.50
OW-10P	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
OW-11A	788.52	788.66	788.71	788.66	788.71	788.63	788.58	788.56	788.59	788.61	788.71	788.76	788.79	788.76	788.84
OW-11P	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
OW-12A	787.61	787.00	787.31	785.95	786.46	785.25	785.25	785.28	785.63	785.13	785.70	786.02	785.60	786.03	786.45
OW-13A	785.72	785.81	785.65	785.83	785.83	785.51	785.50	785.55	785.86	789.42	785.72	785.80	785.77	785.67	785.72
OW-13B	NM	NM	NM	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed
OW-13P	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	obstructed
OW-14P	790.06	790.10	790.11	790.04	790.13	790.07	790.13	790.20	790.20	790.19	790.21	790.22	790.10	790.76	790.11
OW-15P	796.33	796.48	796.25	796.00	796.65	795.98	795.71	795.84	796.31	796.65	796.16	797.04	796.40	795.97	796.77
OW-16P	792.40	792.54	792.15	791.89	791.89	791.81	791.61	791.59	791.71	791.56	791.52	791.81	791.48	791.96	792.18
OW-17P	789.19	789.03	789.24	789.22	789.23	789.24	789.24	789.31	789.33	789.34	789.41	789.46	789.36	789.26	789.28
PS-1	786.34	785.99	786.01	785.68	785.76	785.97	786.08	786.01	786.02	785.74	786.02	786.01	785.72	785.83	786.05
PS-2	786.95	786.43	786.60	786.78	786.96	786.81	786.54	786.98	786.49	786.84	786.79	786.56	786.66	786.91	786.59
PS-3	786.07	786.38	786.36	786.39	786.19	786.27	786.21	786.36	786.21	786.36	786.30	786.26	786.22	785.74	786.34
PS-4	786.97	787.34	786.97	787.03	786.96	786.59	786.64	787.31	786.54	787.32	787.14	787.32	787.09	789.54	786.75
PS-5	794.65	794.47	793.78	794.47	794.47	793.93	794.22	794.69	793.91	794.25	794.63	793.72	794.56	793.78	794.70
PS-6	791.05	791.06	791.06	790.52	790.50	790.05	789.73	789.81	790.21	789.91	789.95	790.38	789.81	790.66	790.79
PS-7	789.89	790.06	789.88	790.24	790.14	789.83	789.81	789.87	790.21	794.54	790.04	790.12	790.12	789.94	790.03
PS-8	790.69	790.81	790.74	790.93	790.91	790.76	790.93	790.91	790.91	790.45	790.84	790.93	790.92	790.80	791.07
PS-9	790.10	790.11	789.79	789.79	789.67	790.06	790.04	790.06	790.04	790.02	789.71	789.67	789.92	789.84	790.06
PS-10	792.44	792.65	792.67	792.35	792.67	792.45	792.57	792.49	792.48	792.45	792.57	792.45	792.43	792.45	791.75
SG-1	782.13	782.08	782.04	782.00	782.04	782.08	782.16	782.38	782.20	782.18	782.32	782.26	782.24	782.14	782.26
SG-2	791.50	791.40	791.04	791.40	793.74	791.40	791.50	791.55	791.50	NM	791.50	791.50	791.10	792.50	791.60

See Notes on Page 4.

Table A-1 -- Allied OU - Historical Groundwater and Portage Creek Elevation Monitoring Data, 2006 - 2009

Location	Groundwater Elevation in feet AMSL												
	4/24/2007	5/29/2007	6/13/2007	7/30/2007	8/29/2007	9/18/2007	12/21/2007	3/12/2008	6/26/2008	9/24/2008	12/14/2008	3/6/2009	6/25-6/26/09
FW-101	796.63	795.99	795.36	794.96	795.86	795.39	796.67	796.78	795.65	796.10	796.74	796.73	795.70
GWE-1	788.71	788.59	788.50	788.28	788.33	788.35	783.27	788.70	788.57	788.46	788.39	788.86	783.26
GWE-1A	786.11	782.93	786.13	785.70	785.53	785.63	785.38	781.25	785.93	785.36	785.53	785.53	787.95
GWE-1P	788.67	808.60	808.60	808.60	808.60	808.60	808.60	808.60	808.60	808.60	803.20	803.20	797.53
GWE-4A	781.26	780.34	782.24	778.41	778.99	779.63	776.16	779.96	794.21	792.12	789.41	792.34	782.62
MW-5R	793.12	792.88	792.77	792.43	792.72	792.49	792.74	793.23	792.89	793.27	792.94	793.39	793.10
MW-6	798.25	798.18	798.06	797.65	798.00	797.67	797.73	798.25	798.22	798.75	798.17	798.55	798.61
MW-7	800.46	799.81	799.68	799.24	799.67	799.25	799.33	799.99	799.84	800.68	799.83	800.30	800.30
MW-8A	799.44	799.39	799.21	798.84	799.29	799.02	799.23	799.52	799.40	799.49	799.42	799.64	799.54
MW-16B	787.36	787.29	787.13	786.77	786.88	786.64	786.43	787.35	787.27	787.74	787.16	787.25	787.61
MW-19BR	796.33	796.06	795.90	795.26	795.29	795.14	795.18	796.41	795.08	796.51	796.44	796.69	797.49
MW-22AR	787.04	787.46	787.82	788.11	788.39	788.60	789.15	789.51	788.87	789.89	788.83	789.24	788.58
MW-22B	793.03	793.00	792.95	792.71	793.57	792.83	792.98	793.31	793.33	792.21	789.30	792.55	792.38
MW-23AR	796.02	796.00	795.91	795.69	795.91	795.78	795.86	796.15	796.12	796.17	796.02	796.20	793.65
MW-24R	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed
MW-26	787.60	787.63	787.57	787.47	787.68	787.64	787.78	787.69	787.59	787.60	787.79	787.68	787.58
MW-120A	801.34	800.97	800.72	799.96	799.99	800.28	800.84	801.68	800.90	800.86	800.78	801.48	801.06
MW-120B	798.94	798.80	798.62	798.13	798.62	798.30	798.53	799.13	798.92	799.43	798.84	799.31	799.06
MW-122A	790.72	790.68	790.59	790.43	790.59	790.50	790.40	790.73	790.74	790.76	790.65	790.77	790.82
MW-122AR	791.34	791.29	791.18	791.02	791.10	791.03	790.98	791.32	791.35	791.25	791.23	791.43	791.38
MW-122B	790.55	790.40	790.35	790.16	790.66	790.11	790.09	790.55	790.45	790.58	790.46	790.78	791.03
MW-124A	813.78	813.49	813.11	812.82	812.75	812.41	809.75	812.29	813.89	814.78	812.45	814.07	814.62
MW-124B	803.30	803.23	803.08	802.24	802.56	802.41	802.41	803.15	803.33	803.28	803.04	803.73	803.68
MW-125A	792.73	792.53	792.27	791.25	792.62	791.64	792.27	792.53	792.81	792.70	792.75	793.15	793.06
MW-126A	795.78	795.58	795.49	795.28	795.76	795.61	796.47	796.46	796.05	796.00	795.58	795.78	795.57
MW-126AR	794.35	794.30	794.32	794.04	794.27	794.15	794.32	794.57	794.52	793.99	793.98	794.24	794.09
MW-200A	795.78	795.78	795.68	795.38	795.67	795.48	795.58	795.78	795.76	795.35	795.46	795.66	795.52
MW-201B	795.93	795.92	795.82	795.60	795.80	795.67	795.77	796.05	796.00	796.02	795.83	795.99	795.89
MW-202B	795.80	795.90	795.72	795.53	795.73	795.61	795.67	795.95	796.00	796.07	795.86	796.03	792.19
MW-203B	794.52	794.51	794.44	794.30	794.51	794.42	794.40	794.65	794.67	794.71	794.52	794.64	790.38
MW-204B	805.31	805.22	805.03	804.14	804.57	804.39	804.35	DRY	805.23	805.27	805.15	802.25	805.86
MW-205B	793.36	793.23	793.09	792.56	792.71	792.51	792.47	793.27	793.29	793.45	793.15	793.70	793.70
MW-206A	796.37	796.27	796.25	795.99	796.20	796.06	796.14	796.45	796.40	796.11	796.13	796.37	796.25
MW-207	795.27	795.24	795.20	794.98	795.20	795.13	795.18	795.51	795.53	794.74	794.79	795.02	794.90
MW-208	795.86	795.82	795.80	795.52	795.72	796.13	795.80	796.14	796.13	794.48	794.65	794.95	790.70
MW-209	792.06	792.04	791.90	791.55	791.74	791.56	791.54	792.12	792.08	792.28	NM	overflowing	NA
MW-210	794.46	794.43	794.38	794.25	794.47	794.37	794.40	794.67	794.69	794.74	794.30	794.48	794.39
MW-211	791.44	791.43	791.31	791.03	791.25	791.10	791.09	791.49	791.53	791.60	791.57	791.79	791.74
MW-212	787.87	787.79	787.67	787.57	787.63	787.50	787.47	787.96	787.83	787.91	787.84	787.81	788.31
MW-213	791.18	791.14	791.03	790.80	791.01	790.88	790.87	791.19	791.17	791.20	NM	791.48	791.53
MW-214	787.66	787.41	787.24	787.31	787.11	787.16	787.51	787.74	787.37	787.52	787.73	787.82	787.63
MW-215	782.95	783.03	782.38	782.08	780.86	782.86	783.33	783.29	782.59	783.09	783.41	783.51	782.66
MW-216	781.97	782.06	782.17	782.30	782.37	782.19	781.89	782.05	782.49	782.30	782.15	782.12	782.19
MW-217	782.72	783.31	782.92	782.93	782.96	782.82	782.57	782.77	783.08	782.92	782.81	782.91	782.91
MW-218	785.65	785.62	785.62	785.44	785.47	785.31	784.95	785.39	785.56	785.45	785.44	785.51	785.71

See Notes on Page 4.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table A-1 -- Allied OU - Historical Groundwater and Portage Creek Elevation Monitoring Data, 2006 - 2009

Location	Groundwater Elevation in feet AMSL												
	4/24/2007	5/29/2007	6/13/2007	7/30/2007	8/29/2007	9/18/2007	12/21/2007	3/12/2008	6/26/2008	9/24/2008	12/14/2008	3/6/2009	6/25-6/26/09
MW-219	784.42	784.46	784.51	784.42	784.44	784.27	783.52	783.92	784.32	784.16	784.13	784.37	784.49
MW-220	785.08	784.46	784.02	783.10	783.94	783.83	783.96	785.17	784.61	785.91	784.14	785.27	784.15
MW-221R	782.08	782.08	782.05	782.27	782.34	782.23	782.01	782.13	782.19	782.28	782.25	782.12	782.08
MW-222	793.63	794.07	793.54	793.45	793.65	793.58	793.57	793.00	793.74	793.51	793.44	793.58	793.54
MW-223	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	792.75
MW-224	792.02	790.75	790.46	790.01	790.38	790.18	791.14	791.67	790.54	792.01	790.70	792.45	790.89
MW-225	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	787.34
MW-226	783.50	783.48	783.37	783.25	783.66	783.48	783.67	783.64	783.59	783.61	783.75	783.67	783.46
MW-227	781.30	781.91	780.84	NM	781.59	NM	782.23	782.37	NM	781.79	782.59	782.38	781.55
MW-228	783.04	783.05	782.79	782.71	782.94	782.80	783.35	783.30	782.85	783.23	783.56	783.50	782.91
MW-229	783.41	783.61	782.78	NM	783.37	782.69	783.83	783.86	782.88	783.49	784.01	783.82	783.24
MW-230	785.48	785.46	784.39	783.55	785.54	784.66	785.30	785.58	784.77	785.57	785.67	785.68	785.12
MW-231	786.46	786.45	786.48	786.53	786.72	786.53	obstructed	obstructed	786.76	786.73	NM	784.64	786.68
MW-232	783.07	783.03	783.00	783.14	783.19	783.05	782.72	783.09	783.17	783.38	783.14	783.28	783.16
OW-1A	785.60	785.48	785.39	785.16	785.26	785.09	785.03	785.60	785.53	785.60	785.45	785.86	785.98
OW-2A	787.06	787.01	786.98	787.04	787.04	787.02	787.02	787.17	787.16	787.21	787.19	787.31	787.18
OW-2B	789.47	789.40	789.31	789.01	789.18	789.07	789.05	789.45	789.57	789.62	789.55	789.82	789.76
OW-2P	786.98	786.95	786.94	787.00	786.99	786.99	786.91	787.05	787.07	787.12	787.04	787.15	787.06
OW-3AR	788.77	787.81	787.85	787.88	787.99	788.01	788.12	788.03	788.01	787.92	790.01	787.93	787.72
OW-3PR	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	obstructed	obstructed
OW-4AR	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	791.96	792.74	792.28	792.70	obstructed	792.42	dry/damaged
OW-4PR	797.31	797.35	797.39	797.39	797.34	797.30	797.01	797.24	794.33	794.18	793.76	794.04	797.14
OW-5P	797.33	796.97	796.79	796.08	796.64	796.72	797.23	798.32	797.36	797.41	796.90	798.14	dry/damaged
OW-6A	796.05	796.05	795.94	795.70	795.89	795.75	796.30	796.63	796.56	796.76	796.35	796.52	796.42
OW-6P	800.55	799.62	798.81	797.20	798.22	797.96	799.42	800.37	798.53	798.53	798.67	800.77	799.29
OW-7P (OW-7PR)	789.35	789.39	789.37	789.10	789.07	789.04	788.44	789.27	789.54	789.27	789.22	789.64	789.76
OW-8A	785.09	783.91	785.73	784.94	obstructed	obstructed	obstructed	obstructed	NM	NM	obstructed	obstructed	obstructed
OW-9PR	792.53	792.65	792.57	792.60	792.64	792.66	792.65	792.58	792.62	792.67	792.64	792.58	792.65
OW-10P	dry	dry	dry	dry	dry	dry	obstructed	obstructed	NM	NM	obstructed	obstructed	obstructed
OW-11A	788.82	788.72	788.68	789.02	788.68	788.59	788.59	788.87	788.72	788.79	788.71	788.99	788.98
OW-11P	dry	dry	dry	dry	dry	dry	obstructed	obstructed	NM	NM	786.97	obstructed	obstructed
OW-12A	786.76	787.14	787.28	787.26	787.96	788.06	788.86	789.70	789.58	789.35	787.18	789.28	787.34
OW-13A	785.72	785.86	785.80	785.72	785.95	785.96	786.04	786.05	786.01	786.19	785.99	786.15	785.92
OW-13B	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	793.55	obstructed	obstructed
OW-13P	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed
OW-14P	790.95	790.14	790.18	790.21	790.33	790.32	790.31	790.23	790.41	790.38	790.25	790.23	790.26
OW-15P	796.48	796.01	795.95	795.28	796.60	795.75	796.23	796.84	796.14	796.18	796.19	797.00	796.29
OW-16P	792.30	792.36	792.47	792.38	792.53	792.66	793.11	793.74	792.59	793.52	792.25	789.29	792.65
OW-17P	789.35	789.31	789.34	789.38	789.43	789.41	789.34	789.46	789.47	789.96	789.46	789.58	789.38
PS-1	785.93	785.85	786.00	785.87	786.00	786.00	785.98	785.73	786.09	785.99	786.00	786.11	NM
PS-2	786.67	786.38	786.78	788.10	786.81	786.81	786.89	786.66	786.76	786.53	786.24	786.54	NM
PS-3	786.25	785.21	786.42	785.91	786.35	786.23	786.40	786.23	785.86	786.33	785.79	786.36	NM
PS-4	790.14	786.76	786.96	786.69	786.93	787.07	786.79	786.89	786.97	786.91	786.72	786.59	NM
PS-5	793.91	794.46	794.57	794.13	794.09	794.00	794.20	796.90	796.26	793.81	794.20	794.53	NM
PS-6	790.86	791.24	790.94	791.13	790.66	791.04	790.86	791.16	790.77	791.03	791.09	793.73	NM
PS-7	790.04	790.17	790.07	789.99	790.19	790.19	790.15	790.17	790.18	790.23	790.16	790.33	NM
PS-8	790.82	790.85	790.90	790.95	790.76	790.96	790.70	790.96	790.92	790.97	790.85	790.88	NM
PS-9	790.10	789.71	789.74	789.70	789.87	789.94	789.73	789.91	789.76	789.86	789.94	789.64	NM
PS-10	792.50	792.13	792.45	792.55	792.45	792.62	792.55	792.73	792.73	792.93	791.85	792.25	NM
SG-1	782.10	782.15	782.10	782.29	782.38	782.32	NM	NM	NM	NM	NM	NM	781.92
SG-2	791.55	791.55	791.35	791.40	791.50	791.55	NM	NM	NM	NM	NM	NM	791.30

Notes:
NM = not measured.
feet AMSL = feet above mean sea level.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
Groundwater level for MW-209 was at the top of casing.

Table A-2 -- Strebor Property - Historical Groundwater Elevation Monitoring Data

Well Number	Top of Casing Elevation (feet AMSL)[1]	3/1/2004[2]		6/1/2004[2]		9/1/2004[2]		3/1/2005[2]		6/1/2005[2]		9/1/2005[2]		3/1/2006[2]	
		Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)
MW-1	802.79	NM		NM		NM		NM		NM		NM		NM	
MW-7	795.28	NM		NM		NM		NM		NM		NM		NM	
MW-15	797.23	NM		NM		NM		NM		NM		NM		NM	
MW-21	794.63	NM		NM		NM		NM		NM		NM		NM	
MW-24	795.04	NM		NM		NM		NM		NM		NM		NM	
MW-25	795.04	NM		NM		NM		NM		NM		NM		NM	
MW-30A	796.32	12.94	783.38	12.74	783.58	13.06	783.26	11.30	785.02	12.44	783.88	13.51	782.81	12.52	0.22
MW-35	794.88	NM		NM		NM		NM		NM		NM		NM	
MW-36	788.55	NM		NM		NM		NM		NM		NM		NM	
MW-37	788.28	NM		NM		NM		NM		NM		NM		NM	
MW-38	781.5	NM		NM		NM		NM		NM		NM		NM	
MW-39	781.55	NM		NM		NM		NM		NM		NM		NM	
MW-40	796.51	6.82	789.69	6.56	789.95	NM		5.94	790.57	5.95	790.56	6.61	789.9	6.61	789.9

Well Number	Top of Casing Elevation (feet AMSL)[1]	6/1/2006[2]		9/1/2006[2]		12/1/2006[2]		3/1/2007[2]		9/1/2007[2]		12/1/2007[2]		3/1/2008[2]	
		Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)
MW-1	802.79	NM		NM		NM		NM		NM		NM		NM	
MW-7	795.28	NM		NM		NM		NM		NM		NM		NM	
MW-15	797.23	NM		NM		NM		NM		NM		NM		NM	
MW-21	794.63	NM		NM		NM		NM		NM		NM		NM	
MW-24	795.04	NM		NM		NM		NM		NM		NM		NM	
MW-25	795.04	NM		NM		NM		NM		NM		NM		NM	
MW-30A	796.32	13.02	783.3	12.64	783.68	12.74	783.58	12.07	784.25	13.3	783.02	12.86	783.46	12.3	784.02
MW-35	794.88	NM		NM		NM		NM		NM		NM		NM	
MW-36	788.55	NM		NM		NM		NM		NM		NM		NM	
MW-37	788.28	NM		NM		NM		NM		NM		NM		NM	
MW-38	781.5	NM		NM		NM		NM		NM		NM		NM	
MW-39	781.55	NM		NM		NM		NM		NM		NM		NM	
MW-40	796.51	6.58	789.93	6.58	789.93	6.6	789.91	6.15	790.36	6.83	789.68	6.69	789.82	6.11	790.4

Well Number	Top of Casing Elevation (feet AMSL)[1]	6/1/2008[2]		9/1/2008[2]		March 23 - April 1, 2009[2]	
		Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)
MW-1	802.79	NM		NM		10.05	792.74
MW-7	795.28	NM		NM		8.06	787.22
MW-15	797.23	NM		NM		9.25	787.98
MW-21	794.63	NM		NM		9.84	784.79
MW-24	795.04	NM		NM		9.68	785.36
MW-25	795.04	NM		NM		7.87	787.17
MW-30A	796.32	13.17	783.15	13.55	782.77	NM	
MW-35	794.88	NM		NM		8.89	785.99
MW-36	788.55	NM		NM		9.52	779.03
MW-37*	788.28	NM		NM		4.82	783.46
MW-38	781.5	NM		NM		7.46	774.04
MW-39*	781.55	NM		NM		NM	
MW-40*	796.51	6.56	789.95	6.91	789.6	5.65	790.86

See Notes on Page 2.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table A-2 -- Strebor Property - Historical Groundwater Elevation Monitoring Data

Notes:
ft = feet
AMSL = above mean sea level.
Quarterly depth to water measurements were provided by Bay West on April 7, 2009. The exact dates when measurements were collected during the quarter were not included in the data transmission, so it was assumed that the measurements were collected on the first day of each quarter.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
[1] Surveyed by Prein & Newhof in 2009.
[2] Measurements were made by Bay West personnel.
NM = not measured.
TOC = Top of casing
* MW-37, MW-39, and MW-40 are screened in the Regional Aquifer Unit, the other wells are screened in the Surfical Aquifer Unit.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table A-3 -- Panelyte Property - Historical Groundwater Elevation Monitoring Data

Well Number	Aquifer Unit	June 24, 2002		October 20, 2003	
		Depth to Water (ft below TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft below TOC)	Groundwater Elevation (feet AMSL)
MW1	Surficial	8.47	788.69	8.54	788.62
MW2	Surficial	8.80	787.18	9.06	786.92
MW3	Surficial	6.19	793.25	NM	NM
MW4	Surficial	6.84	788.49	6.84	788.49
MW5	Surficial	7.08	787.97	6.90	788.15
MW6	Surficial	7.22	785.48	7.09	785.61
MW7	Surficial	8.53	786.87	8.70	786.70
MW8	Surficial	6.76	789.14	6.59	789.31
MW9	Surficial	0.46	780.65	1.32	779.79
MW10	Surficial	-0.3*	781.86	-0.6*	782.16
MW11	Surficial	1.57	781.38	2.17	780.78

Notes:
ft = feet
AMSL = above mean sea level.
Well construction information and 2002 and 2003 groundwater elevation data are from the Preliminary Site Assessment Report, Former Panelyte Site, Kalamazoo Michigan, Malcolm Pirnie, December 8, 2004.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
* - Static water level was above top of casing. Value is approximate.
NM = not measured.
TOC = Top of casing
Aquifer Unit designations are based on aquifer designations in Figure 2 from the April 30, 2008 MDEQ Memorandum from Brant Fisher to Paul Bucholtz.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table A-4 Performance Paper Property - Historical Groundwater Elevation Monitoring Data

Well Number	Aquifer Unit	9/21/2005		6/8/2006	
		Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)
ATL-03	Surficial	NA	NA	NA	NA
ATL-04	Surficial	20.24	760.03	18.18	762.09
ATL-05	Surficial	10.08	763.34	9.20	764.22
MW2-02	Surficial	18.25	765.15	17.37	766.03
MW-3	Surficial	NA	NA	NA	NA
MW3-01	Surficial	14.38	763.06	NA	NA
MW3-02	Surficial	14.81	763.00	13.55	764.26
MW3-04	Surficial	NA	NA	NA	NA
MW-4	Surficial	NA	NA	NA	NA
MW-5	Surficial	NA	NA	NA	NA
MW-6	Surficial	NA	NA	NA	NA
MW-7	Surficial	NA	NA	NA	NA
MW-9	Surficial	17.02	770.62	16.86	770.78
MW-10D	Surficial	12.29	769.23	11.76	769.76
MW-10S	Surficial	13.87	766.86	13.41	767.32
MW-11	Surficial	8.51	770.45	7.56	771.40
MW-12D	Surficial	5.50	766.15	5.16	766.49
MW-12S	Surficial	6.06	765.35	4.64	766.77
MW-13	Surficial	23.10	765.30	22.03	766.37
MW-14	Surficial	7.55	760.21	6.48	761.28
MW-15D	Surficial	18.46	761.33	NA	NA
MW-15S	Surficial	18.80	760.92	NA	NA
MW-16D	Surficial	16.88	760.48	15.37	761.99
MW-16S	Surficial	16.47	760.47	15.82	761.12
MWB-02	Surficial	NA	NA	NA	NA
MWB-03	Surficial	NA	NA	NA	NA
MWLTI	Surficial	16.72	NA	15.68	NA
PW-1	Surficial	22.19	767.28	21.38	768.09
PW-2	Surficial	20.57	765.61	20.10	766.08
PW-3	Surficial	12.22	766.00	12.09	766.13
PW-4	Surficial	10.78	764.85	9.57	766.06
PW-5	Surficial	10.45	764.59	9.67	765.37
PW-6	Surficial	10.71	763.53	8.72	765.52

Notes:
ft = feet
AMSL = above mean sea level.
NA = not available.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
TOC = Top of casing
Aquifer Unit designations are based on aquifer designations in Figure 2 from the April 30, 2008 MDEQ Memorandum from Brant Fisher to Paul Bucholtz.

ARCADIS

Attachment 2

Preliminary Remedial
Goals Memorandum
(CH2M Hill 2009)

Summarization of Preliminary Remedial Goals Kalamazoo River/Portage Creek OU1 Site WA No. 037-RSBD-059B, Contract EP-S5-06-01

PREPARED FOR: Michael Berkoff / USEPA

PREPARED BY: CH2M HILL

DATE: March 10, 2009

This Technical Memorandum (TM) is prepared for the U. S. Environmental Protection Agency (U.S. EPA) to develop a list of preliminary remedial goals (PRGs) for the Allied Paper Landfill (OU1) of the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site for use during remedial alternative evaluation in the Feasibility Study (FS). This TM provides a qualitative assessment of the exposure pathways, receptors and land use scenarios at OU1 for consideration of PRGs for the various site media. This summary of PRGs will be compared to site-specific data and utilized during the development of an array of potential remedial alternatives in the FS to be prepared by Millennium Holdings. Further, this document will assist U.S. EPA in the evaluation of remedial alternatives presented in the FS and in the development of the ROD.

Early investigative efforts recognized that if the extent of polychlorinated biphenyls (PCBs) in OU1 was identified and appropriately remediated, then other associated hazardous substances would also be addressed (CDM, 2008). This TM is focused on PCBs as the driver for evaluating risk. Other potential contaminants of concern have been identified at OU1 and will need to be considered with PCBs for future remedial actions.

The Michigan Department of Environmental Quality (MDEQ) completed a *Site-wide Final (Revised) Human Health Risk Assessment* (CDM, 2003a) and *Final (Revised) Baseline Ecological Risk Assessment* (CDM, 2003b) for the entire Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. The Human Health Risk Assessment (HHRA) quantitatively assessed potential risks to human health through exposure to media impacted with PCBs, including the consumption of fish, direct contact with contaminated floodplain soils, and inhalation of dust and volatile emissions from floodplain soils. The Baseline Ecological Risk Assessment (BERA) quantitatively assessed potential risks to various ecological receptors for different exposure pathways. U.S. EPA has determined that risk to human and ecological receptors exists at the Site based on the results of the HHRA and BERA. A feasibility study is necessary to evaluate alternatives to mitigate the risks.

Risk-based levels from the HHRA and BERA were compiled with other established risk-based levels and regulatory criteria in the performance of this evaluation. Although the BERA is currently under peer review, the document was used in preparation of this evaluation and consideration of risk-based PRGs. In addition to the quantitative PRGs identified, a qualitative PRG is also recommended that requires either remedial actions where residuals are visually observed or sufficient sampling to verify the residuals do not contain PCB concentrations above the applicable goals.

Conceptual Site Model

To assist with the identification of PRGs, a conceptual site model (CSM) was developed to identify sources, release mechanisms, media, exposure routes, and receptors that may be present at the site. The CSM considers exposures that may occur with residential, recreational, commercial and industrial land uses. Figure 1 presents the CSM based on human receptors. This CSM was developed based on the *Risk Assessment Guidance for Superfund* (U.S. EPA, 1998).

Figure 2 is a modified CSM to consider ecological receptors, but was limited to defining the receptors as terrestrial or aquatic-based receptors. The BERA identified the most sensitive terrestrial receptor as the robin and the most sensitive aquatic receptor as the mink. The risk-based criteria developed based on the robin and mink will be used in later evaluations.

The CSM was prepared to be inclusive of the potential scenarios that may be present in OU1. However, different media and land uses are present throughout the site. Therefore, to evaluate the risks which may be present in the different areas, OU1 was separated into four areas as shown in Figure 3. These areas are consistent with the presentation of investigation data in the RI Report (CDM, 2008) and are identified below with a description of the media present within that area:

– **Former Bryant Mill Pond** – Includes lower elevation floodplain/wetland areas adjacent to Portage Creek. The current creek channel is narrower as a result of the lowering of the Alcott Street Dam gates in 1976. Prior to the removal of these gates, the water level in Portage Creek was higher and ponding occurred over areas that are currently in the floodplain and wetland. Areas of sediment that were exposed after removal of Alcott Street Dam gates have since revegetated (CDM, 2008). The U.S. EPA conducted a removal action in the area in 1998 and 1999 to address PCBs in the sediment. The initial excavation was performed with an action level of 10 mg/kg and a goal of achieving post-excavation PCB concentrations less than or equal to 1 mg/kg.

– **Residential/Commercial Areas** – Is comprised of privately owned residential and commercial lands located outside of the eastern and western boundaries of OU1 where PCB concentrations and residuals were identified during the RI. Step-out sampling was performed to define the extent of impacts away from areas where residuals were observed. As a result, areas of higher concentration may be present and additional characterization may be required for comparison to the selected PRGs.

  This area includes, but is not limited to, the Panelyte Property (excluding the Panelyte Marsh), Stryker Corporation, Conrail, Clay Seam Area, East Bank Area, other properties and the Portage Creek adjacent to this area (CDM, 2008). This area includes surface and subsurface soil and sediment with varied land use. These properties listed above are not a part of OU1 as it has been defined. Any remediation in this area, proposed as a part of the OU1 FS, would be to clean up contamination that spread from OU1.

– **Former Operations Area** – The Former Operations Area includes Bryant historical residuals dewatering lagoon (HRDL) and former residuals dewatering lagoons (FRDLs), Monarch HRDL, Type III Landfill, Western Disposal Area, and the Alcott Street Properties. The landfill cap over the Bryant HRDL and FRDLs is at a higher elevation with lower elevation soils and wetlands present in the area (CDM, 2008). Interim response measures have been completed in the Former Operations Area since the early to mid 1990s and include the following actions:

  - Installation of 2,600 linear feet of sheet pile along the west bank of Portage Creek.
  - Removal and backfill of several hundred cubic yards (cy) of soil containing residuals from locations between the sheet pile wall and Portage Creek, and consolidation into the Bryant HRDL and FRDLs.
  - Removal and backfill of approximately 1,700 cy of residuals located within the floodplain on the east side of Portage Creek (East Bank area) in 2002, and consolidation into the Bryant FRDLs.
  - Construction of a landfill cap over the Bryant HRDL and FRDLs after consolidation of the soils and residuals as described above.
  - Design and installation of a groundwater recovery system to mitigate mounding of shallow groundwater behind the sheet pile along Portage Creek.

  The interim actions will be discussed and incorporated into the alternatives evaluated in the FS. As stated in the final Bryant Mill Pond Administrative Agreement, "The Bryant Mill Pond Area Removal Action is intended to be consistent with what U.S. EPA anticipates will be the final remedy to be selected by MDEQ" (U.S. EPA, 1998).

– **Panelyte Marsh** – The Panelyte Marsh is located at the southeastern end of the Panelyte property, north of the Western Disposal Area. Surface water from the Panelyte fill area and Western disposal area drains towards the Panelyte Marsh, which then drains to Portage Creek (CDM, 2008).

The boundaries presented in Figure 3 are consistent with the RI Report. These boundaries may need to be redefined during the feasibility study or remedial design. The remedial design will need to consider media definition and the current and planned future land-use for each area.

Identification and Development of PRGs

PCBs are the primary contaminant of concern and the risk driver at OU1 (CDM, 2008). Therefore, for the potentially complete pathways identified in the CSMs, a range of PRGs for PCBs were identified for the various media present. The PRGs were identified utilizing information from the HHRA, BERA, and chemical-specific applicable or relevant and appropriate requirements (ARARs).

Attachment 1 includes all the criteria that were considered and a discussion on the applicability and retention of the criteria as a potential PRG. Site-specific risk-based numbers presented in the HHRA and BERA and Part 201 Generic Cleanup Criteria were retained as PRGs for soil, sediment, and groundwater and are presented in Table 1. Screening levels presented in guidance documents (i.e. DOE Oak Ridge National Laboratory Screening levels) were identified, as shown in Attachment 1, but were not retained for further evaluation as PRGs.

PRGs are not included in this evaluation for surface water and fish tissue. By addressing soil, sediment, and groundwater sources, it is anticipated that the surface water and fish will be addressed over time. The fish consumption advisories will be maintained independent of this evaluation.

The relevance of PRGs for a specific area will depend upon the media present along with the receptors and current and future land use. The PRGs included in Table 1 for consideration are discussed below:

- Sediment criteria of 0.33 mg/kg, protective of human health based on consumption of fish. The risk-based criteria developed in the HHRA for protection of human health based on fish consumption are below the MDEQ ERD/SWQD detection limit of 0.33 mg/kg for sediment, so 0.33 mg/kg is the default sediment criteria (CDM, 2003a). The sediment criteria are also applied to areas that are inundated. The period of inundation that is applicable is currently being developed. The criteria was developed assuming the pathway from sediment to fish to consumer is complete.
- Under Michigan Rule 201 R299.5728 (f), the response action must provide for the effective control of contaminated soils from erosion.
- Sediment criteria of 0.5 mg/kg to 0.6 mg/kg protective of aquatic ecological receptors based on the NOAEL and LOAEL for mink (CDM, 2003b).
- Soil criteria of 2.5 mg/kg, protective of human health in a residential land-use scenario with exposure to contaminated soil via ingestion, dermal contact, and inhalation (CDM, 2003a).
- Soil criteria of 6.5 mg/kg to 8.1 mg/kg protective of terrestrial ecological receptors based on the NOAEL and LOAEL for the robin (CDM, 2003b).
- Soil criteria of 16 mg/kg, protective of human health in a commercial/industrial land-use scenario based on Part 201 criteria (MDEQ, 2004).
- Soil criteria of 23 mg/kg protective of human health for a recreationalist in a non-residential land-use scenario with exposure to contaminated soil via ingestion, dermal contact, and inhalation (CDM, 2003a).
- Groundwater criteria of 0.2 µg/L protective of surface water where a groundwater/surface water interface (GSI) is present based on Part 201 criteria (MDEQ, 2004).
- Groundwater criteria of 3.3 µg/L protective of human health through direct contact with groundwater based on Part 201 criteria (MDEQ, 2004).
- Removal of residuals observed in soil and sediment based on visual identification unless sufficient analytical data is available to demonstrate PCBs are not present above the applicable goals in a target area.

Sensitivities

This TM was prepared based on available information from the RI Report and assumptions in development of the CSM. The key assumptions and other limitations are summarized below:

- Area boundaries shown in Figure 3 are based on the RI study areas. Boundaries may require further evaluation and breakdown during the FS for application of the PRGs.
- The HHRA sediment cleanup criteria protective of human health from fish consumption has a range of 0.04 mg/kg to 0.30 mg/kg for PCBs. Because the MDEQ detection limit of 0.33 mg/kg for PCBs is greater than the risk-based level, the PRG protective of people consuming fish defaults to 0.33 mg/kg.
- Sediment criteria of 0.33 mg/kg is based on sediment to fish to human being complete pathway.
- PCB concentrations have been detected in the shallow groundwater aquifer. The drinking water pathway is considered incomplete at the site since no drinking water wells are present.
- The drinking water pathway may be incomplete for off site areas given the following reasons:
    - Several confining layers between the shallow and deep aquifers have been observed in city supply wells (CDM, 2008), that are located approximately 1 mile from the site.
    - An upward gradient from the deep to the shallow aquifer has been observed in the same nearby city supply wells (CDM, 2008).
    - No PCB contamination has been detected in the municipal well field sampling. The well field has been monitored for the last 20 years; however, with the exception of 2007, reporting limits were greater than the maximum contaminate level (MCL). Data from 2007 had reporting limits less than the MCL and PCBs were not detected in the samples.
    - PCBs are considered relatively insoluble and are thought to not migrate significantly in groundwater (CDM, 2008).
    - Onsite shallow groundwater flow is believed to follow the regional topography to the east where it discharges to Portage Creek (CDM, 2008).
    - Regionally, shallow groundwater flow is to the north, side gradient to the municipal well field located to the northwest of the site.

  Controls should be established within OU1 to prevent the installation of drinking water wells onsite and completion of the drinking water pathway. Zoning currently prevents installation of wells if public water supply is available. Should new information provide evidence of a completed drinking water pathway, the PRGs for groundwater will be re-evaluated.

– PRGs are not included in this evaluation for surface water and fish tissue. By addressing soil, sediment, and groundwater, it is anticipated that the surface water and fish will be addressed over time.

The default sediment criteria of 0.33 mg/kg for PCBs is roughly equivalent to the risk-based concentration of 0.30 mg/kg for the Sport Angler - Central Tendency based on fish consumption for 24 meals per year. OU1 is only one of five operable units in the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. This criteria was identified to be protective of human health whether an angler is catching fish only within this operable unit or within the site as a whole.

Future Use

It is U.S. EPA's intent that this summary of PRGs will be used by the Responsible Parties in the development of the FS. The information in this document will be compared to site-specific data and used in the development of an array of alternatives in the FS. U.S. EPA will use the information summarized in this TM in consideration of remedies for this OU.

References

CDM, 2003a. *Final (Revised) Human Health Risk Assessment (HHRA) of the Allied Paper, Inc./Portage Creek/Kalamazoo River (API/PC/KR) Superfund Site.* April 2003.

CDM, 2003b. *Final (Revised) Baseline Ecological Risk Assessment (BERA) for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site.* April 2003.

CDM, 2008. *Allied Paper Inc. Operable Unit Remedial Investigation Report, for the Allied Paper, Inc/Portage Creek/Kalamazoo River Superfund Site.* April 2008.

MDEQ, 2004. *RRD Operational Memorandum No. 1, Part 201 Cleanup Criteria, Part 213 Risk-based Screening Levels.* December 10, 2004.

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U.S. EPA, 1989. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A).* Office of Emergency and Remedial Response. U.S. EPA/540/1-89/002

U.S. EPA. 1998. CERCLA Docket No. V-W-98-C-473. Final Administrative Agreement executed by the US Department of Justice on June 2, 1998.

Figures

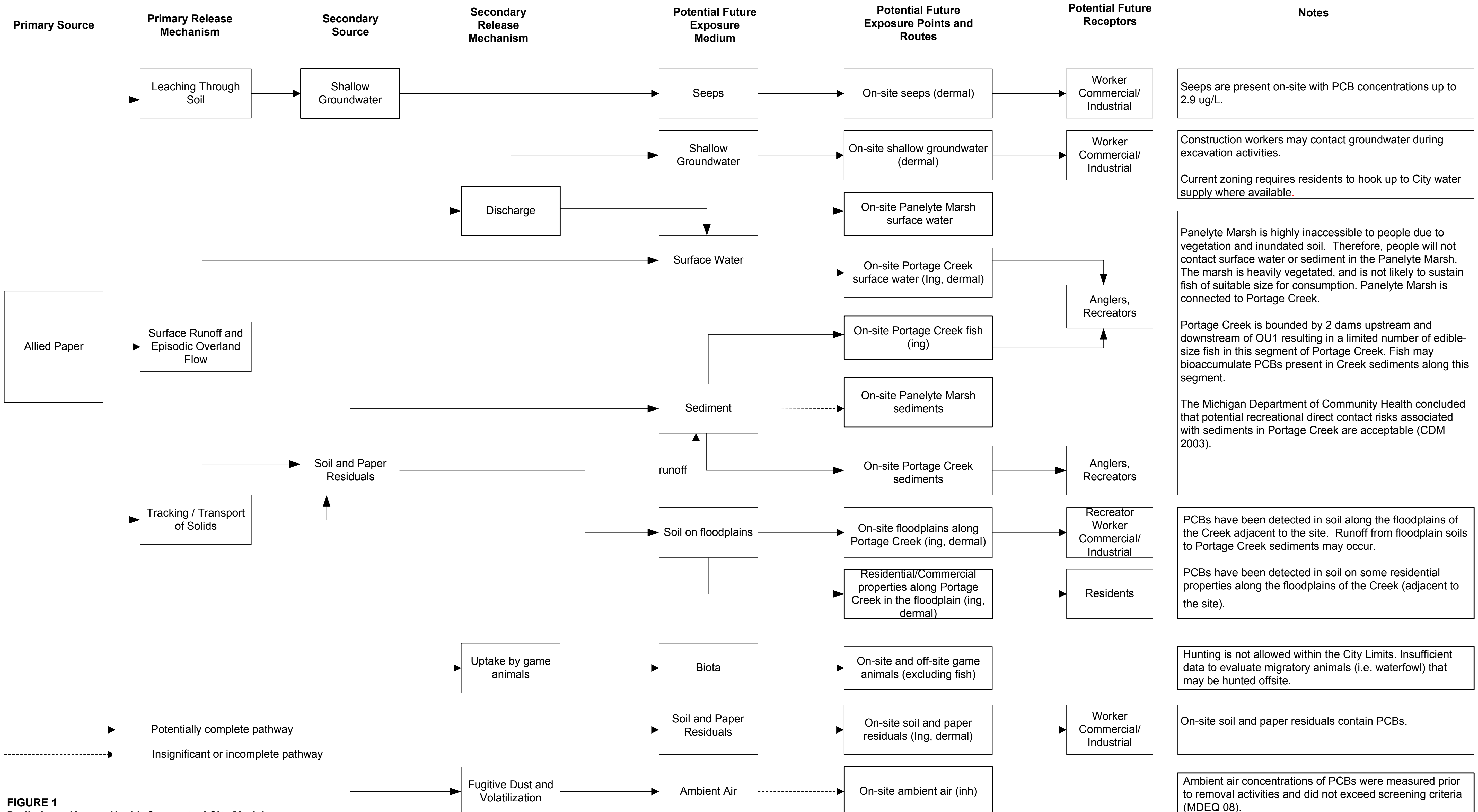

FIGURE 1
Preliminary Human Health Conceptual Site Model
Allied Paper OU-1

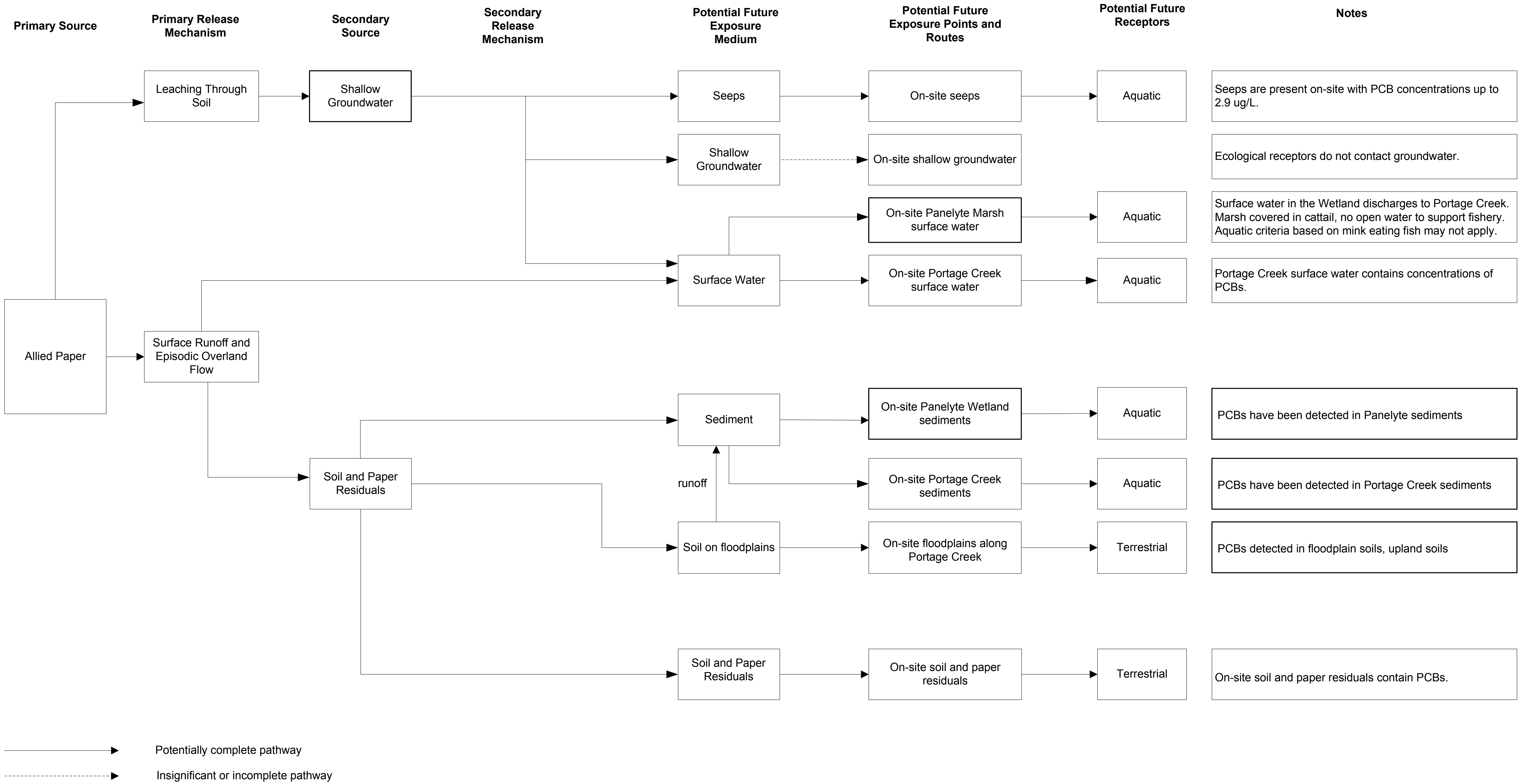

FIGURE 2
Preliminary Ecological Conceptual Site Model
Allied Paper OU-1

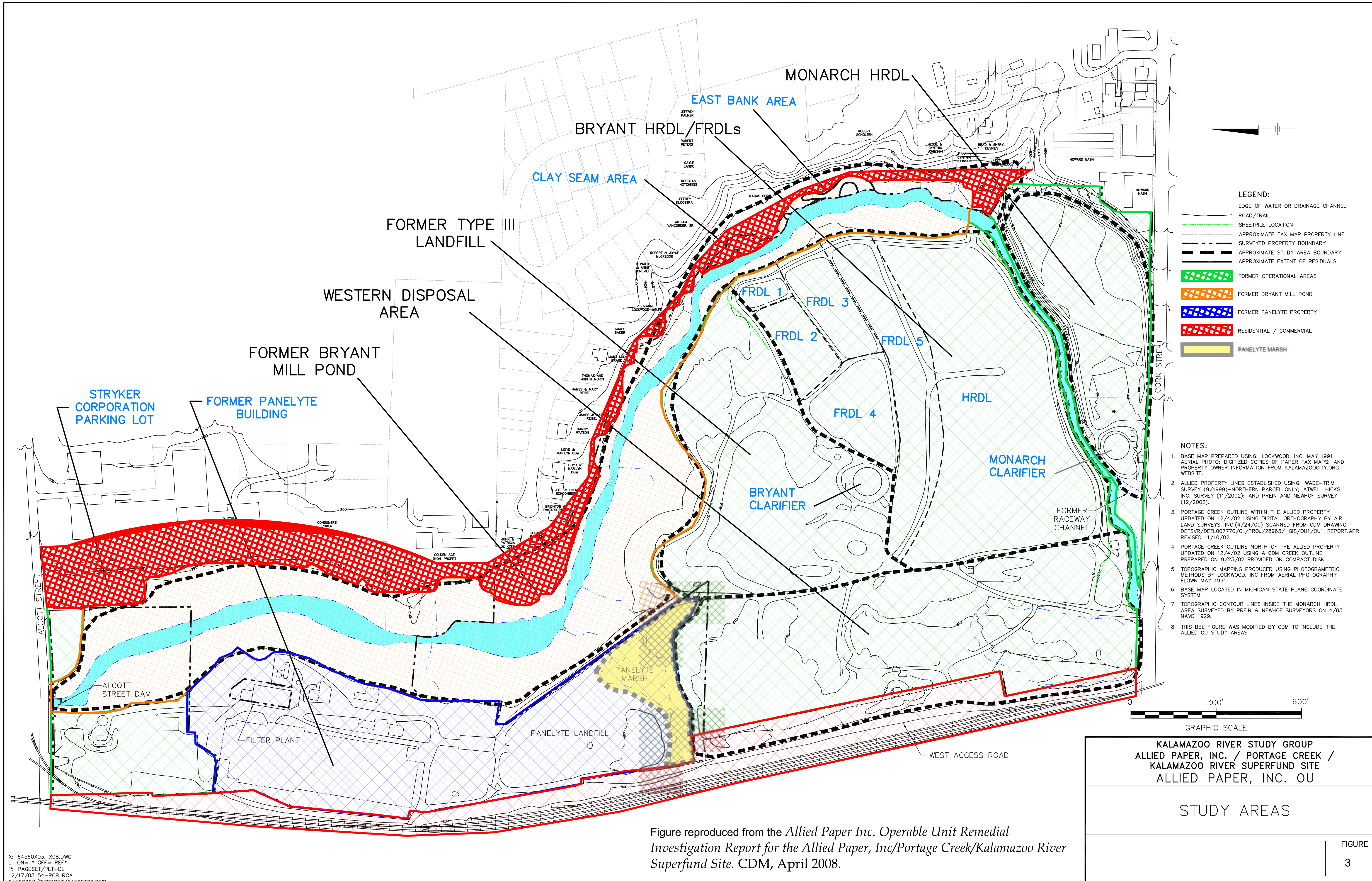

Figure reproduced from the *Allied Paper Inc. Operable Unit Remedial Investigation Report for the Allied Paper, Inc/Portage Creek/Kalamazoo River Superfund Site.* CDM, April 2008.

Tables

Table 1
Preliminary Remedial Goals
Draft Preliminary Remedial Goal Identification

Media	Pathway		Source	Preliminary Remedial Goals
Surface Soils	Human Health	Fish Consumption [1]	HHRA	0.33 mg/kg [1]
		Residential	HHRA	2.5 mg/kg
		Commercial II /Industrial	201 Generic Cleanup Criteria	16 mg/kg
		Recreationalist	HHRA	23 mg/kg
	Ecological	Aquatic	BERA	0.5 mg/kg / 0.6 mg/kg
		Terrestrial	BERA	6.5 mg/kg / 8.1 mg/kg
Subsurface Soils	Human Health	Residential	HHRA	2.5 mg/kg
		Commercial II /Industrial	201 Generic Cleanup Criteria	16 mg/kg
		Commercial/Industrial	HHRA	23 mg/kg
	Ecological	Terrestrial	BERA	6.5 mg/kg / 8.1 mg/kg
Surface Sediments	Human Health	Fish Consumption	HHRA	0.33 mg/kg
	Ecological	Aquatic	BERA	0.5 mg/kg / 0.6 mg/kg
Subsurface Sediment	Human Health	Fish Consumption	HHRA	0.33 mg/kg
	Ecological	Aquatic	BERA	0.5 mg/kg / 0.6 mg/kg
Groundwater (including seeps)	Human Health [2]		201 Generic Cleanup Criteria	3.3 µg/L
	Surface Water [3]		201 Generic Cleanup Criteria	0.2 µg/L

[1] Default sediment criteria of 0.33 mg/kg will be applied to shallow soil in areas of periodic inundation due to the potential runoff of shallow soils into surface water. Evaluation of contaminated soil runoff to surface water required under R299.5728(f)

[2] Groundwater for use as drinking water is not considered a complete pathway so the Part 201 Drinking Water criteria of 0.5 µg/L was not used. The Part 201 direct contact criteria was used for protection of human health due to the presence of seeps.

[3] The groundwater criteria protective of surface water is a PRG where the GSI is present.

Attachment 1

Summary of Suggested Remedial Goals and Applicable or Relevant and Appropriate Requirements

Citation	Summary of Requirement	Criteria
Soil		
Final (Revised) Human Health Risk Assessment (HHRA) of the Allied Paper, Inc./Portage Creek/Kalamazoo River (API/PC/KR) Superfund Site. CDM, April 2003	The HHRA calculated risk-based concentrations (RBCs) for PCBs in soil protective of residents and recreationalists. RBCs were developed for both cancer and noncancer endpoints. Risk-based concentrations were developed for PCBs using an allowable cancer risk of 1 in 100,000 and a noncancer hazard index of 1.0. The RBC for soil would be protective of residents exposed to contaminated soil via ingestion, dermal contact, and inhalation. For the cancer endpoint the RBC for soil is 2.5 mg/kg. For noncancer endpoints, the RBC is 15 mg/kg for the reproductive endpoint and 4 mg/kg for the immunological endpoint. RBCs protective of recreationalists exposed to contaminated soil via ingestion, dermal contact, and inhalation include a RBC 23 mg/kg for cancer endpoints. For noncancer endpoints, the RBC is 139 mg/kg for the reproductive endpoint and 32 mg/kg for the immunological endpoint. The HHRA criteria are site-specific values calculated for the Kalamazoo River Superfund Site. The 1E-05 values calculated for cancer endpoints are the most protective values and were retained as PRGs for residential (2.5 mg/kg) land use and for protection of a recreationalist with non-residential land use (23 mg/kg).	<u>Residential</u> 1E-5 RIsk 2.5 mg/kg HI = 1.0 (immunological) 4 mg/kg HI = 1.0 (reproductive) 15 mg/kg <u>Non-residential</u> 1E-5 RIsk 23 mg/kg HI = 1.0 (immunological) 32 mg/kg HI = 1.0 (reproductive) 139 mg/kg
Michigan Natural Resources and Environmental Protection Act— Part 201 of Act 451 (Part 7 R299.5701- 5707, 5718-5752)	Provides generic cleanup criteria and screening levels for direct contact with soil. Part 7 adopts the criteria established by TSCA; however, it also provides direct contact criteria for soil if TSCA standards are not applicable. If TSCA standards are not applicable, Generic Residential Land Use Criteria of 4 mg/kg PCB (soil) is established to be protective of human health for residential land-use under Part 201, Environmental Remediation of Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, and Part 201 Administrative Rules. If TSCA standards are not applicable, Generic Commercial II and Industrial Land Criteria of 16 mg/kg PCBs (soil) is established to be protective of human heath for onsite workers and/or trespassers under Part 201, Environmental Remediation of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, and Part 201 Administrative Rules. The Part 201 Residential cleanup criteria of 4 mg/kg is less protective than the residential criteria developed in the HHRA and was therefore not retained as a PRG.	Residential 4 mg/kg Industrial 16 mg/kg

Citation	Summary of Requirement	Criteria	
	The Part 201 Commercial / Industrial cleanup criteria of 16 mg/kg, was considered as a PRG for industrial / commercial land use.		
Final (Revised) Baseline Ecological Risk Assessment (BERA) for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. CDM, April 2003.	The No Observed Adverse Effect Level (NOAEL) to Lowest Observed Adverse Effect Level (LOAEL) range from 6.5 mg/kg to 8.1 mg/kg PCB in soil for the protection of terrestrial ecological receptors (the American Robin) as established in the Baseline Ecological Risk Assessment (BERA). The BERA is currently under peer review, but was used for evaluation of PRGs. The NOAEL and LOAEL are site-specific values calculated for the Kalamazoo River Superfund Site and are retained as PRGs for evaluation of terrestrial ecological receptors.	NOAEL LOAEL	6.5 mg/kg 8.1 mg/kg
DOE Oak Ridge National Laboratory (ORNL) *Screening Levels for Chemical Contaminants* including the Region 9 PRG (http://epa-prgs.ornl.gov/chemicals/index.shtml)	Generic screening levels (SLs) are based on default exposure parameters and factors that represent Reasonable Maximum Exposure (RME) conditions for long-term/chronic exposures and are based on the methods outlined in EPA's Risk Assessment Guidance for Superfund, Part B Manual (1991) and Soil Screening Guidance documents. The screening levels provided correspond to a 10-6 cancer risk for high risk PCBs, such as Aroclors 1242, 1248, 1254, and 1260. Region 9 Preliminary Remediation Goals (PRGs) protective of human health for the ingestion, inhalation and dermal contact exposure pathways for soil are 0.22 mg/kg for residential use (high risk PCBs) and 0.74 mg/kg for industrial land-use (high risk PCBs). Region 9 PRGs are intended for use as screening levels to determine if remedial actions may be necessary, but are not intended to be used as cleanup criteria. The Region 9 PRGs are not regulatory criteria or site-specific values and were not carried forward for further evaluation as PRGs.	Residential Industrial	0.22 mg/kg 0.74 mg/kg
USEPA, Office of Emergency and Remedial Response, EPA 540/G-90/007 (OSWER Directive 9355.4-01)	Describes the recommended approach for evaluating and remediating Superfund Sites with PCBs. Provides preliminary remediation goals for certain media and other considerations. Recommends that the goals for soils generally should be 1 ppm for residential areas, or higher (10–25 ppm) for sites where non-residential use is anticipated. The guidance document provides preliminary remedial goals based on land uses. These are not regulatory criteria or site-specific values, so the criteria were not retained as PRGs.	Residential Non-residential	1 mg/kg 10 - 25 mg/kg

Citation	Summary of Requirement	Criteria
Toxic Substance Control Act—Subpart D (40 CFR 761.50-761.79)	PCBs are regulated by Toxic Substance Control Act (TSCA) under 40 CFR 761. Subpart D of Part 761, Storage and Disposal, establishes procedures for self-implementing clean up of general, moderately-sized sites, including clean up criteria. In place of the self-implementing criteria, TSCA allows for site-specific risk-based criteria to be determined and used under 40 CFR 761.61 (c) *Risk-based disposal approval*. Site-specific values are provided in the HHRA so the TSCA Subpart D criteria were not retained as PRGs.	<u>Residential & Commercial I</u> 1 mg/kg 10 mg/kg if capped <u>Industrial & Commercial II, III or IV</u> 1 mg/kg 10 mg/kg if capped
Toxic Substance Control Act—Subpart G (53 U.S.C. 2301 et seq.; 40 CFR 761.120-761.135)	PCBs are regulated by the Toxic Substance Control Act (TSCA) under 40 CFR 761. Subpart G of Part 761, Spill Cleanup Policy, establishes the criteria by which spill cleanup should be judged. Subpart G applies only to spills that occurred after May 4, 1987. With few exceptions that are left to the discretion of USEPA (40 CFR 761.123 [d][2]), Subpart G promulgates soil cleanup levels for PCB spills of low and high concentrations. For low concentration spills involving less than 1 pound of PCBs by weight, TSCA Subpart G requires all soil within the spill area (i.e., the visible traces of a spill and the 1-foot lateral buffer zone surrounding the visible traces) to be excavated and the ground to be restored with backfill containing less than 1 ppm PCBs. For high concentration spills (or low concentration spills involving more than 1 pound of PCBs by weight), TSCA Subpart G promulgates soil cleanup levels of 10 mg/kg for nonrestricted access areas and 25 mg/kg for restricted access areas. Spills which occurred prior to May 4, 1987, are excluded from the scope of this policy and require site-by-site evaluation. Site-specific values are provided in the HHRA, so the TSCA Subpart G criteria were not retained as PRGs.	Nonrestricted access 10 mg/kg Restricted access 25 mg/kg
Sediment		
Final (Revised) Human Health Risk Assessment (HHRA) of the Allied Paper, Inc./Portage Creek/Kalamazoo River (API/PC/KR) Superfund Site. CDM, April 2003	The HHRA sediment cleanup criteria protective of people consuming fish range from 0.04 mg/kg to 0.30 mg/kg PCB; however, because MDEQ has a detection limit of 0.33 mg/kg for PCBs, the cleanup criteria protective for people consuming fish defaults to 0.33 mg/kg. The risk based concentrations (RBCs) from the HHRA are presented below: <u>RBC for 1E-05 based on Bass/Carp Ingestion</u> Subsistence angler (179 meals/yr) 0.04 mg/kg Sport angler – high end (125 meals/yr) 0.12 mg/kg Sport angler – central tendency (24 meals/yr) 0.30 mg/kg	Default 0.33 mg/kg

Citation	Summary of Requirement	Criteria
	<u>RBC for HQ = 1 based on Bass/Carp Ingestion</u> Subsistence angler (179 meals/yr) 0.07 mg/kg Sport angler – high end (125 meals/yr) 0.20 mg/kg Sport angler – central tendency (24 meals/yr) 0.52 mg/kg The default criteria of 0.33 mg/kg was evaluated as a PRG since the HHRA criteria calculated for the angler are below the analytical detection limit. The default criteria of 0.33 mg/kg was retained as a PRG for sediment.	
Final (Revised) Baseline Ecological Risk Assessment (BERA) for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. CDM, April 2003.	The No Observed Adverse Effect Level (NOAEL) to Lowest Observed Adverse Effect Level (LOAEL) range of 0.5 mg/kg to 0.6 mg/kg PCB in sediment for the protection of aquatic ecological receptors (mink) as established in the BERA. The BERA is currently under review, but was used for evaluation of PRGs. The NOAEL and LOAEL for aquatic receptors are site-specific values calculated for the Kalamazoo River Superfund Site. The NOAEL and LOAEL were retained for consideration as PRGs.	NOAEL 0.5 mg/kg LOAEL 0.6 mg/kg
Toxic Substance Control Act—Subpart D (40 CFR 761.50-761.79)	PCBs are regulated by Toxic Substance Control Act (TSCA) under 40 CFR 761. Subpart D of Part 761, Storage and Disposal, establishes procedures for self-implementing clean up criteria for general, moderately sized sites. The self-implementing criteria are not to be used for sediments. In place of the self-implementing criteria, TSCA allows site-specific risk-based criteria to be determined and used under 40 CFR 761.61 (c) *Risk-based disposal approval*. Site specific values are provided in the HHRA so the TSCA Subpart D criteria were not retained as PRGs.	<u>Residential & Commercial I</u> 1 mg/kg 10 mg/kg if capped <u>Industrial & Commercial II, III or IV</u> 1 mg/kg 10 mg/kg if capped
USEPA, Office of Emergency and Remedial Response, EPA 540/G-90/007 (OSWER Directive 9355.4-01)	*Guidance on Remedial Actions for Superfund Sites with PCB Contamination* prepared by the USEPA, Office of Emergency and Remedial Response, EPA 540/G-90/007 (OSWER Directive 9355.4-01), describes the recommended approach for evaluating and remediating Superfund Sites with PCBs and provides preliminary remediation goals for certain media and other considerations. Interim sediment quality criteria for PCBs are shown in Table 3-5 from the *Guidance on Remedial Actions for Superfund Sites with PCB Contamination*. The guidance document provides a method to determine cleanup levels based on site conditions and assumptions, but does not provide a criteria. This is not a regulatory criteria or site-specific value and was therefore not retained as a PRG.	Based on percent organic carbon (%OC)

Citation	Summary of Requirement	Criteria	
Groundwater			
DOE Oak Ridge National Laboratory (ORNL) *Screening Levels for Chemical Contaminants* including the Region 9 PRG (http://epa-prgs.ornl.gov/ chemicals/index.shtml)	Generic screening levels are based on default exposure parameters and factors that represent Reasonable Maximum Exposure (RME) conditions for long-term/chronic exposures and are based on the methods outlined in EPA's Risk Assessment Guidance for Superfund, Part B Manual (1991). The screening levels provided correspond to a 10^{-6} cancer risk for high risk PCBs, such as Aroclors 1242, 1248, 1254, and 1260. Region 9 Preliminary Remediation Goals (PRG) protective of human health for the ingestion and inhalation exposure pathways is 0.034 µg/L for tap water (high risk PCBs). Region 9 PRGs are intended for use as screening levels to determine if remedial actions may be necessary, but are not intended to be used as cleanup criteria. The screening levels are not regulatory criteria or site-specific values and were not carried forward for further evaluation as PRGs. In addition, a completed pathway is not currently believed to be present for ingestion of the shallow groundwater.	Tap Water	0.034 µg/L
Michigan Natural Resources and Environmental Protection Act— Part 201 of Act 451 (Part 7 R299.5701- 5707, 5718-5752)	Groundwater Surface Water Interface (GSI) Criteria of 0.2 µg/L is presented in Part 201, Environmental Remediation of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, and Part 201 Administrative Rules. The calculated criterion is below the analytical target detection limit; therefore, the criterion defaults to the target detection limit. The Part 201 generic cleanup criteria for groundwater was retained as a PRG where the GSI is present on the site.	GSI	0.2 µg/L
Michigan Natural Resources and Environmental Protection Act— Part 201 of Act 451 (Part 7 R299.5701- 5707, 5718-5752)	Generic Residential and Industrial-Commercial Drinking Water Standard of 0.5 µg/L for PCBs, is presented in Part 201, Environmental Remediation of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, and Part 201 Administrative Rules. Part 201 adopted the criterion which is the State of Michigan drinking water standard established pursuant to section 5 of 1976 PA 399, MCL 325.1005. A completed pathway is not currently believed to be present for ingestion of the shallow groundwater. A PRG for groundwater based on ingestion was not evaluated.	Drinking Water	0.5 µg/L
Michigan Natural Resources and Environmental Protection Act— Part 201 of Act 451	Groundwater Contact Criteria of 3.3 µg/L for PCBs, presented in Part 201, Environmental Remediation of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, and Part 201 Administrative Rules.	Direct Contact	3.3 µg/L

Citation	Summary of Requirement	Criteria
(Part 7 R299.5701- 5707, 5718-5752)	A shallow water table is present in the area with the expression of seeps to the ground surface. The Part 201 generic cleanup criteria to be protective of human health through contact with groundwater was retained as a PRG.	
Surface Water		
Clean Water Act—Water Quality Standards (33 U.S.C. 1311 et. seq.; 40 CFR 131)	The Clean Water Act and the Michigan Natural Resources and Environmental Protection Act regulate concentrations of PCBs in surface waters. According to the Clean Water Act National Toxics Rule (40 CFR 131.36; as updated by USEPA on November 9, 1999 [64 *FR* 61181]), the water quality criterion for total PCBs in surface water is 0.00017 µg/L for both the water-and-organism consumption and water-only consumption human health criteria. The 2002 update to the National Recommended Water Quality Criteria established pursuant to Section 303(a) of the Clean Water Act for total PCBs are 0.000064 µg/L for both types of human health criteria and 0.014 µg/L for the freshwater aquatic life criteria continuous concentration. PRGs were not developed for surface water. PCBs in surface water will be addressed as a result of remedial actions for soil and sediment.	<u>1999</u> Human Health 0.00017 µg/L <u>2002 Update</u> Human Health 0.000064 µg/L Freshwater Aquatic Life 0.014 µg/L
Michigan Natural Resources and Environmental Protection Act –Part 31 of Act 451 (Part 4 R323.1041-1117)	According to Part 4 (Water Quality Standards) Rule 57 (Toxic Substances) of the Administrative Rules for Part 31 (Water Resources Protection) of the Michigan Administrative Code, the acceptable levels of PCBs in surface water are 0.000026 µg/L for human health (both drinking and nondrinking uses) and 0.00012 µg/L for wildlife. PRGs were not developed for surface water. PCBs in surface water will be addressed as a result of remedial actions for soil and sediment.	Human Health 0.000026 µg/L Wildlife 0.00012 µg/L
Final (Revised) Baseline Ecological Risk Assessment (BERA) for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. CDM, April 2003.	The No Observed Adverse Effect Level (NOAEL) to Lowest Observed Adverse Effect Level (LOAEL) range from 0.00098 µg/L to 0.00197 µg/L PCB for the protection of aquatic ecological receptors (mink) as established in the BERA. The BERA is currently under review, but the NOAEL and LOAEL are provided for comparison to other potential ARARs. PRGs were not developed for surface water. PCBs in surface water will be addressed as a result of remedial actions for soil and sediment.	NOAEL 0.00098 µg/L LOAEL 0.00197 µg/L
Fish Tissue		
Food and Drug Administration	Tolerances for PCBs in food for human consumption are identified in 21 CFR 109.30 for residues of PCB as unavoidable environmental or industrial contaminants in foods	Fish fillets 2 mg/kg

Citation	Summary of Requirement	Criteria
Tolerances for PCBs in food for human consumption (21 CFR 109.30)	for human consumption "until the elimination of such contaminants at the earliest possible time." Temporary tolerance for PCBs in the edible portions of fish (excludes head, scales, viscera, and inedible bones) is 2 ppm. Provides guidance for actions involving fish consumption advisories. PRGs were not developed for fish. PCBs in fish will be addressed through remedial actions for soil and sediment.	
Michigan Department of Community Health (MDCH) Fish Contaminant Monitoring Program (FCMP) (referenced from HHRA)	The MDCH Fish Contaminant Monitoring Program evaluates fish samples for PCBs and other potential contaminants in determination of fish consumption advisories. The Trigger Levels for total PCBs in fish as determined by the MDCH Fish Contaminant Monitoring Program are as shown. PRGs were not developed for fish. PCBs in fish will be addressed through remedial actions for soil and sediment. The fish consumption advisories will be maintained independent of this evaluation.	General Population 2.0 mg/kg Women of Child-Bearing Age and Children Under 15 1 meal/ wk 0.05 mg/kg 1 meal/mo 0.2 mg/kg 6 meals/yr 1.0 mg/kg No consumption 1.9 mg/kg
Final (Revised) Human Health Risk Assessment (HHRA) of the Allied Paper, Inc./Portage Creek/Kalamazoo River (API/PC/KR) Superfund Site. CDM, April 2003.	Risk-based fish concentrations were developed to be protective of sport and subsistence anglers for both cancer and noncancer endpoints. Risk-based concentrations were developed for PCBs using an allowable cancer risk of 1 in 100,000 and a noncancer hazard index of 1.0. For the noncancer risk, only the immunological endpoint was calculated because this is more protective than the reproductive endpoint and is always a lesser concentration. The RBCs represent the concentration in the fillet. <u>RBC for 1E-05 based on Bass/Carp Ingestion</u> Subsistence angler (179 meals/yr) 0.015 mg/kg Sport angler – high end (125 meals/yr) 0.042 mg/kg Sport angler – central tendency (24 meals/yr) 0.109 mg/kg <u>RBC for HQ = 1 based on Bass/Carp Ingestion</u> Subsistence angler (179 meals/yr) 0.025 mg/kg Sport angler – high end (125 meals/yr) 0.072 mg/kg Sport angler – central tendency (24 meals/yr) 0.187 mg/kg PRGs were not developed for fish. PCBs in fish will be addressed through remedial actions for soil and sediment.	RBC for 1E-05 risk based on Bass/Carp Ingestion range from 0.015 mg/kg to 0.109 mg/kg.

Attachment 3

Land Use Map from the Portage Creek Corridor Reuse Plan

Figure S-4
Existing Land Use

ARCADIS

Attachment 4

Comparison of
Remedial Investigation
PCB Data to Screening
Criteria

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Table A4-1 -- Comparison of Detected Total PCB Concentrations in Surface Soils and Residuals Samples to Preliminary Remediation Goals

Station ID	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg) [1]	USEPA Preliminary Remedial Goals (mg/kg) [2]	Exceedance (Y/N)	RI Report Data Source
Former Operational Areas						
Monarch						
MLSS-2	0-0.5	110	4	6.5	Y	Table 4-2J(CD)
MLSS-3	0-0.5	17	4	6.5	Y	Table 4-2J(CD)
Former Type III Landfill						
FLF-1	0-0.5	85	4	6.5	Y	Table 4-2J(CD)
Western Disposal Area						
MW-206A	0-0.5	8.4	4	6.5	Y	Table 4-2J(CD)
WA-6	0-0.5	8.8	4	6.5	Y	Table 4-2J(CD)

Notes:
[1] RI Report screening criteria from Table 4-2B.
[2] USEPA Preliminary Remediation Goal for PCBs in soil is 2.5 mg/kg in residential areas, 16 mg/kg in commercial/industrial areas, and 6.5 mg/kg for areas to be protective of terrestrial ecological receptors.
RI Report - Remedial Investigation Report (MDEQ 2008)
mg/kg - milligrams per kilogram.
ft bgs - feet below ground surface.

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Table A4-2 -- Comparison of Detected Total PCB Concentrations in Subsurface Soils and Residuals Samples to Preliminary Remediation Goals

Station ID	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg)[1]	USEPA Preliminary Remedial Goals (mg/kg)[2]	Exceedance (Y/N)	RI Report Data Source
Former Operational Areas						
Monarch						
MLSS-1[3]	8-10	59-95	4	6.5	Y	Table 4-2K(CD)
MLSS-1	10-12	97	4	6.5	Y	Table 4-2K(CD)
MLSS-1	12-14	23	4	6.5	Y	Table 4-2K(CD)
MLSS-2	14-16	18	4	6.5	Y	Table 4-2K(CD)
MLSS-2	16-18	89	4	6.5	Y	Table 4-2K(CD)
MLSS-2	18-20	61	4	6.5	Y	Table 4-2K(CD)
MLSS-3	12-14	120	4	6.5	Y	Table 4-2K(CD)
MLSS-3	14-16	28	4	6.5	Y	Table 4-2K(CD)
MLSS-4	12-14	47	4	6.5	Y	Table 4-2K(CD)
MLSS-4	14-16	35	4	6.5	Y	Table 4-2K(CD)
MLSS-4	16-18	23	4	6.5	Y	Table 4-2K(CD)
MLSS-5	18-20	13	4	6.5	Y	Table 4-2K(CD)
MW-126B	10-12	85	4	6.5	Y	Table 4-2K(CD)
MW-125B	14-16	140	4	6.5	Y	Table 4-2K(CD)
MW-125B	16-18	29	4	6.5	Y	Table 4-2K(CD)
Former Type III Landfill						
FLF-1	2-4	260	4	6.5	Y	Table 4-2K(CD)
FLF-1	4-6	240	4	6.5	Y	Table 4-2K(CD)
FLF-1	6-6.5	75	4	6.5	Y	Table 4-2K(CD)
FLF-2	20-22	2,000	4	6.5	Y	Table 4-2K(CD)
RP-2	4-4.5	16	NR	2.5	Y	Table 4-2K(CD)

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Table A4-2 -- Comparison of Detected Total PCB Concentrations in Subsurface Soils and Residuals Samples to Preliminary Remediation Goals

Station ID	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg)[1]	USEPA Preliminary Remedial Goals (mg/kg)[2]	Exceedance (Y/N)	RI Report Data Source
Western Disposal Area						
WA-1	10-12	22	4	6.5	Y	Table 4-2K(CD)
WA-2	6-8	600	4	6.5	Y	Table 4-2K(CD)
WA-6	4-6	1,100	4	6.5	Y	Table 4-2K(CD)
WA-6	8-10	480	4	6.5	Y	Table 4-2K(CD)
WA-6	10-12	800	4	6.5	Y	Table 4-2K(CD)
WA-6	12-13	300	4	6.5	Y	Table 4-2K(CD)
WA-7	20-22	39	4	6.5	Y	Table 4-2K(CD)
WA-8	2-4	1,100	4	6.5	Y	Table 4-2K(CD)
WA-8	6-8	260	4	6.5	Y	Table 4-2K(CD)
WA-8	8-10	51	4	6.5	Y	Table 4-2K(CD)
WA-8	10-12	120	4	6.5	Y	Table 4-2K(CD)
MW-8A	4-6	370	4	6.5	Y	Table 4-2K(CD)
MW-8A	8-10	220	4	6.5	Y	Table 4-2K(CD)
MW-8A	10-12	330	4	6.5	Y	Table 4-2K(CD)
MW-8A	12-12.5	220	4	6.5	Y	Table 4-2K(CD)
MW-120B[3]	6-8	180-630	4	6.5	Y	Table 4-2K(CD)
MW-120B	10-12	69	4	6.5	Y	Table 4-2K(CD)
MW-120B	14-16	2,500	4	6.5	Y	Table 4-2K(CD)
MW-120B	16-18	330	4	6.5	Y	Table 4-2K(CD)
MW-120B	18-19	130	4	6.5	Y	Table 4-2K(CD)

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Table A4-2 -- Comparison of Detected Total PCB Concentrations in Subsurface Soils and Residuals Samples to Preliminary Remediation Goals

Station ID	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg)[1]	USEPA Preliminary Remedial Goals (mg/kg) [2]	Exceedance (Y/N)	RI Report Data Source
Bryant HRDL/FRDLs						
BHDL-22	6-8	430	4	6.5	Y	Table 4-2K(CD)
BHDL-22	8-10	93	4	6.5	Y	Table 4-2K(CD)
BHDL-22 [3]	10-12	9.9-17	4	6.5	Y	Table 4-2K(CD)
BHDL-123	6-8	195	4	6.5	Y	Table 4-2K(CD)
BHDL-123	8-9.5	174	4	6.5	Y	Table 4-2K(CD)
DLHB-6 [3]	6-8	14-120	4	6.5	Y	Table 4-2K(CD)
DLHB-6	8-10	19	4	6.5	Y	Table 4-2K(CD)
MW-12R	8-10	100	4	6.5	Y	Table 4-2K(CD)
MW-121B	10-12	650	4	6.5	Y	Table 4-2K(CD)
MW-121B	12 -14	96	4	6.5	Y	Table 4-2K(CD)
MW-121B	14-16	51	4	6.5	Y	Table 4-2K(CD)
MW-121 B	16-17.5	27	4	6.5	Y	Table 4-2K(CD)
P-1	12-14	35	4	6.5	Y	Table 4-2K(CD)
Commercial Properties						
RD-1A	-	16.96	4	2.5	Y	Appendix MDEQ B

Notes:
[1] RI Report screening criteria from Table 4-2D.
[2] USEPA Preliminary Remediation Goal for PCBs in soil is 2.5 mg/kg in residential areas, 16 mg/kg in commercial/industrial areas, and 6.5 mg/kg for areas to be protective of terrestrial ecological receptors.
[3] Multiple samples were analyzed at location. Range of detected concentrations is presented.
RI Report - Remedial Investigation Report (MDEQ 2008)
mg/kg - milligrams per kilogram.
ft bgs - feet below ground surface.
NR - criterion not reported in RI Report

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Table A4-3 -- Comparison of Detected Total PCB Concentrations in Surface Sediment Samples to Preliminary Remediation Goals

Station ID	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg)[1]	USEPA Preliminary Remedial Goals (mg/kg) [2]	Exceedance (Y/N)	RI Report Data Source
Former Operation Areas						
Monarch						
RC-1[3]	0.6 - 1.1	10.2-12.3	0.33	0.5	Y	Table 4-5C(CD)
Western Disposal Area						
PM-4 [3]	0.3 - 0.7	4.4-5.3	0.33	0.5	Y	Appendix MDEQ B
Former Type III Landfill						
BMP-SEEP-G	Assumed surficial	0.7	0.33	0.5	Y	Appendix MDEQ B
BMP-SEEP-H	Assumed surficial	5.4	0.33	0.5	Y	Appendix MDEQ B
BMP-SEEP-I	Assumed surficial	2.2	0.33	0.5	Y	Appendix MDEQ B
BMP-SEEP-J	Assumed surficial	1.1	0.33	0.5	Y	Appendix MDEQ B

Notes:
[1] RI Report screening criteria from Table 4-3F.
[2] USEPA Preliminary Remediation Goal for PCBs in sediments is 0.5 mg/kg where required to be protective of aquatic ecological receptors.
[3] Multiple samples were analyzed at location. Range of detected concentrations is presented.
RI Report - Remedial Investigation Report (MDEQ 2008)
mg/kg - milligrams per kilogram.
ft bgs - feet below ground surface.

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Table A4-4 -- Comparison of Detected Total PCB Concentrations in Groundwater Samples to Preliminary Remediation Goals

Station ID	Concentration (µg/L)	RI Report Screening Criteria (µg/L)[1]	USEPA Preliminary Remedial Goals (mg/kg)[2]	Exceedance (Y/N)	RI Report Data Source
Former Operational Areas					
Western Disposal Area					
FW-101[3]	0.4/0.246	0.2	0.2	Y	Appendix MDEQ B
MW-8A[3]	0.28/0.549	0.2	0.2	Y	Appendix MDEQ and Table 4-4D(CD)
Bryant HRDL/FRDLs					
MW-122AR[3]	0.12/0.3822	0.2	0.2	Y	Appendix MDEQ B

Notes:
[1] RI Report screening criteria from RI Report Table 4-4H.
[2] USEPA Preliminary Remedation Goal is 0.2 µg/L for groundwater.
[3] Multiple samples were analyzed at location. Range of detected concentrations is presented.
RI Report - Remedial Investigation Report (MDEQ 2008)
µg/L - micrograms per liter.

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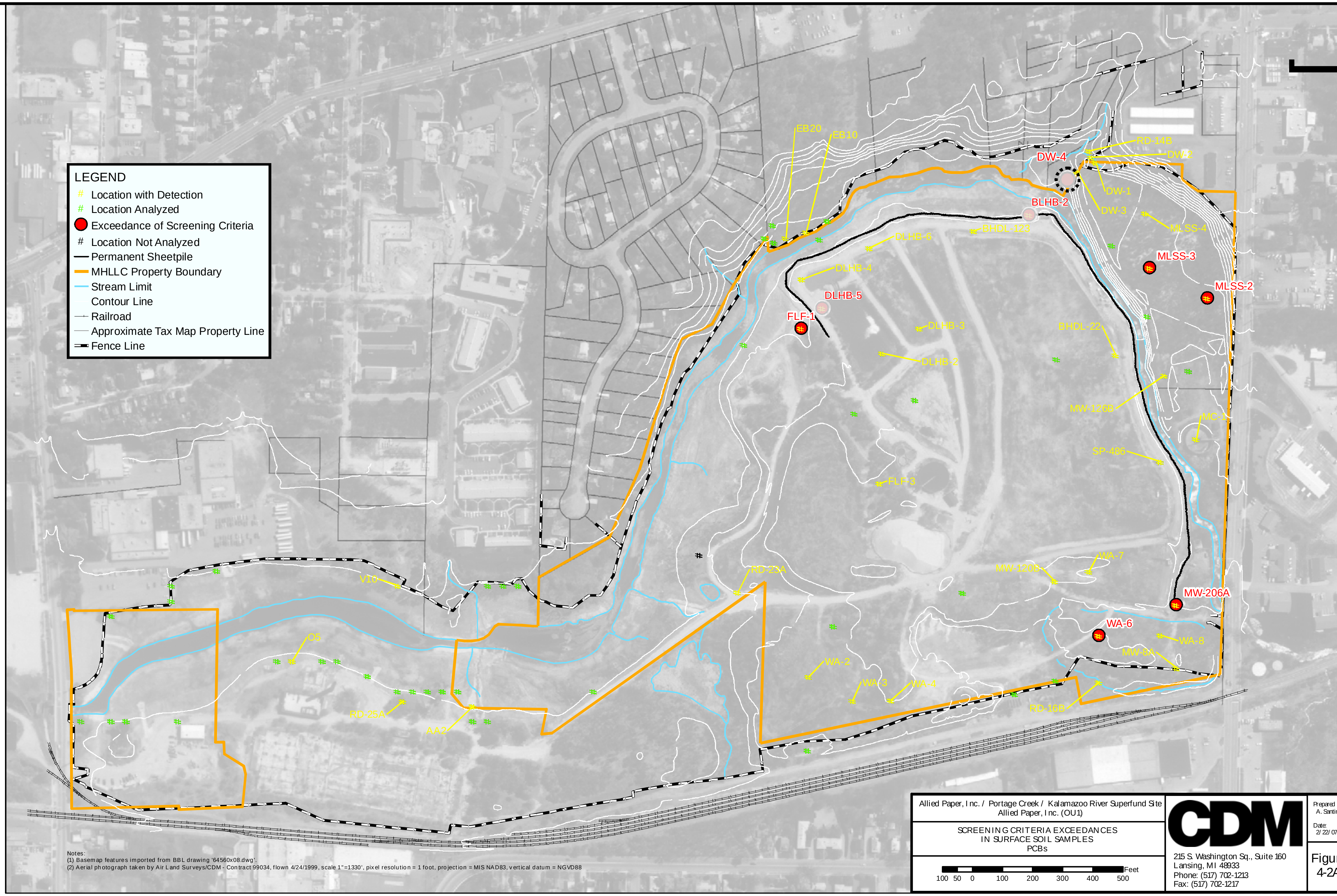
Table A4-5 -- Comparison of Detected Total PCB Concentrations in Groundwater Seep Samples to Preliminary Remediation Goals

Station ID	Concentration (µg/L)	RI Report Screening Criteria (µg/L)[1]	Groundwater-Surface Water Interface Criteria (µg/L)[2]	Exceedance (Y/N)	RI Report Data Source
Former Type III Landfill					
SP-G	0.9	0.2	0.2	Y	Table 4-4H(CD)
SP-H [3]	1.4-2.9	0.2	0.2	Y	Table 4-4H(CD)

Notes:
[1] RI Report screening criteria from Table 4-4H.
[2] USEPA Preliminary Remedation Goal is 0.2 µg/L for groundwater seeps.
[3] Multiple samples were analyzed at location. Range of detected concentrations is presented.
RI Report - Remedial Investigation Report (MDEQ 2008)
µg/L - micrograms per liter.



Legend:

= Sample location meets inorganic constituent groundwater-surface water interface criteria.

= Newly identified location of exceedance of Mercury groundwater-surface water interface protection criterion.

Note:

1. USEPA PRG for Surface Soils is 2.5 mg/kg PCBs for residential areas, 16 mg/kg for commercial/industrial areas, and 6.5 mg/kg for areas to be protective of terrestrial ecological receptors.

2. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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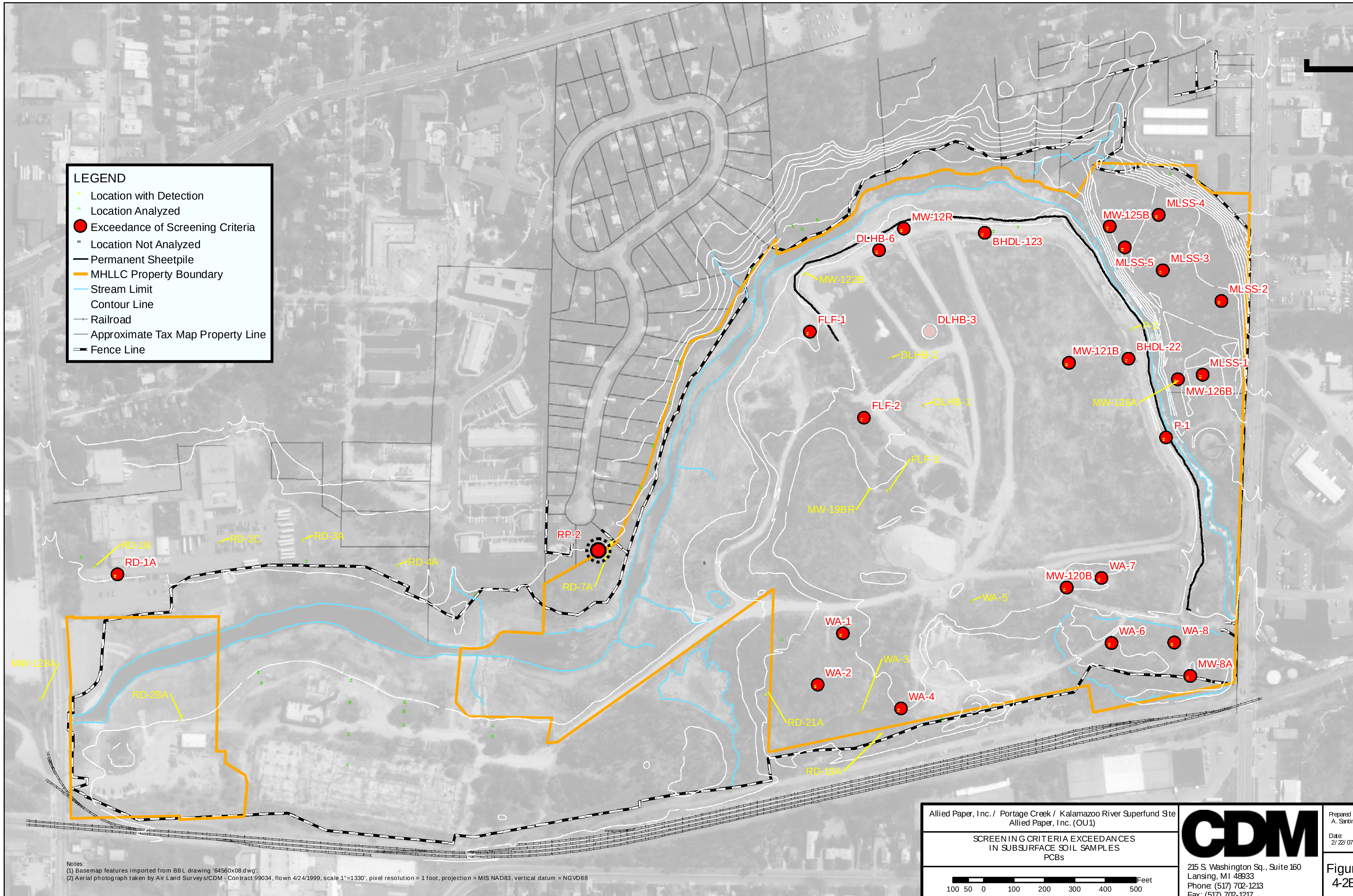
ALLIED PAPER, INC. OU

SURFACE SOIL SAMPLES EXCEEDING USEPA PRGs FOR PCBs

ARCADIS

FIGURE
A4-1

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI,
B0064587/0001/00002/CDR/64587G02.CDR



Legend:

= Sample location meets subsurface soil PCB criterion.

= Newly identified location exceeding subsurface soil PCB criterion.

Note:

1. USEPA PRG for Subsurface Soils is 2.5 mg/kg PCBs for residential areas, 16 mg/kg for commercial/industrial areas, and 6.5 mg/kg for areas to be protective of terrestrial ecological receptors.
2. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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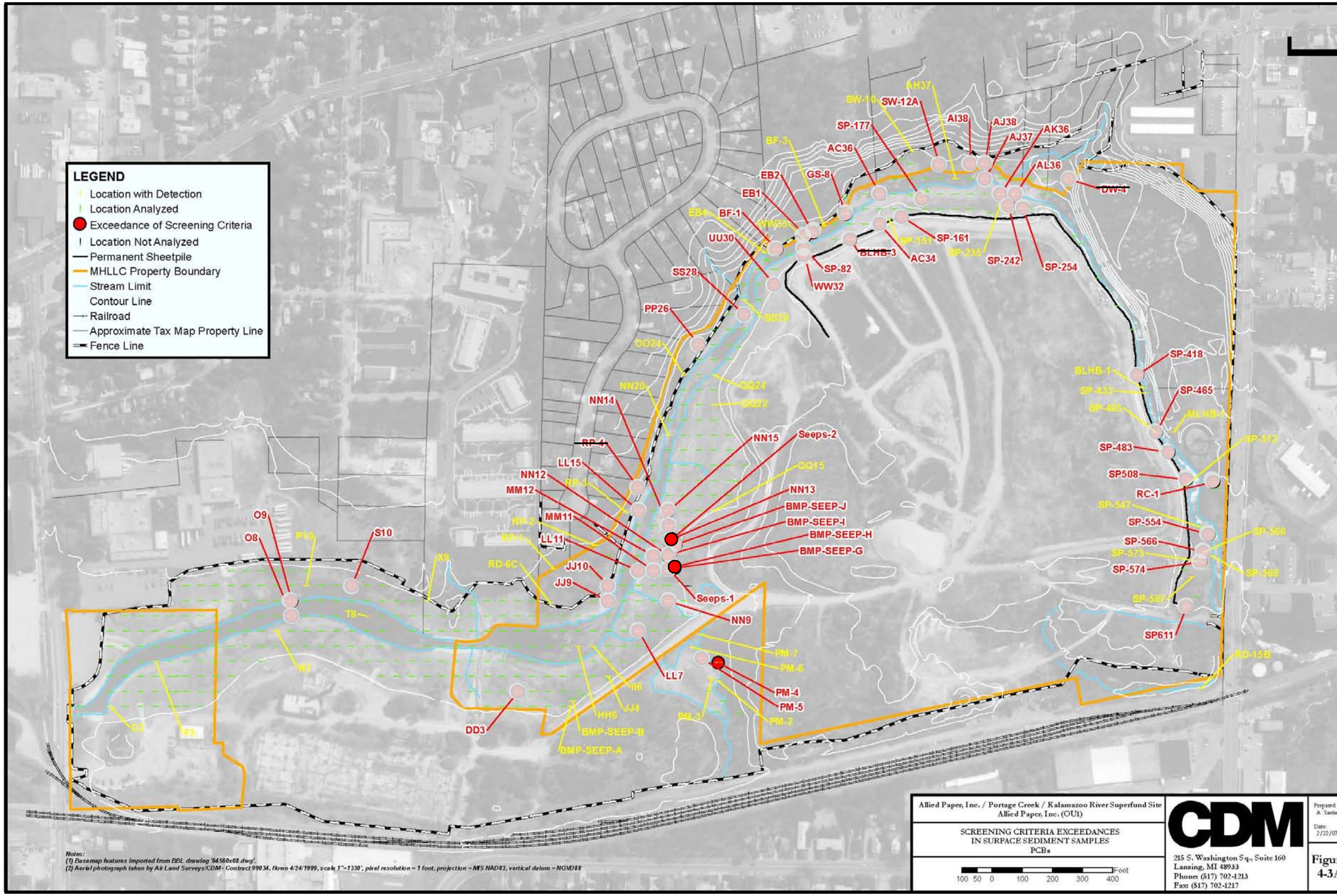
SUBSURFACE SOIL SAMPLES EXCEEDING USEPA PRGs FOR PCBs

ARCADIS

FIGURE
A4-2

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G01.CDR



Legend:

= Sample location meets sediment criterion and/or was addressed by TCRA or IRM.

Notes:

1. USEPA PRG for PCBs in Surface Sediment is 0.5 mg/kg.
2. Samples DW-4 and RP-4 were identified in the RI Report (MDCQ, 2008) as surface sediment samples. The FS considers these to be surface soil samples (see Figure A4-5).
3. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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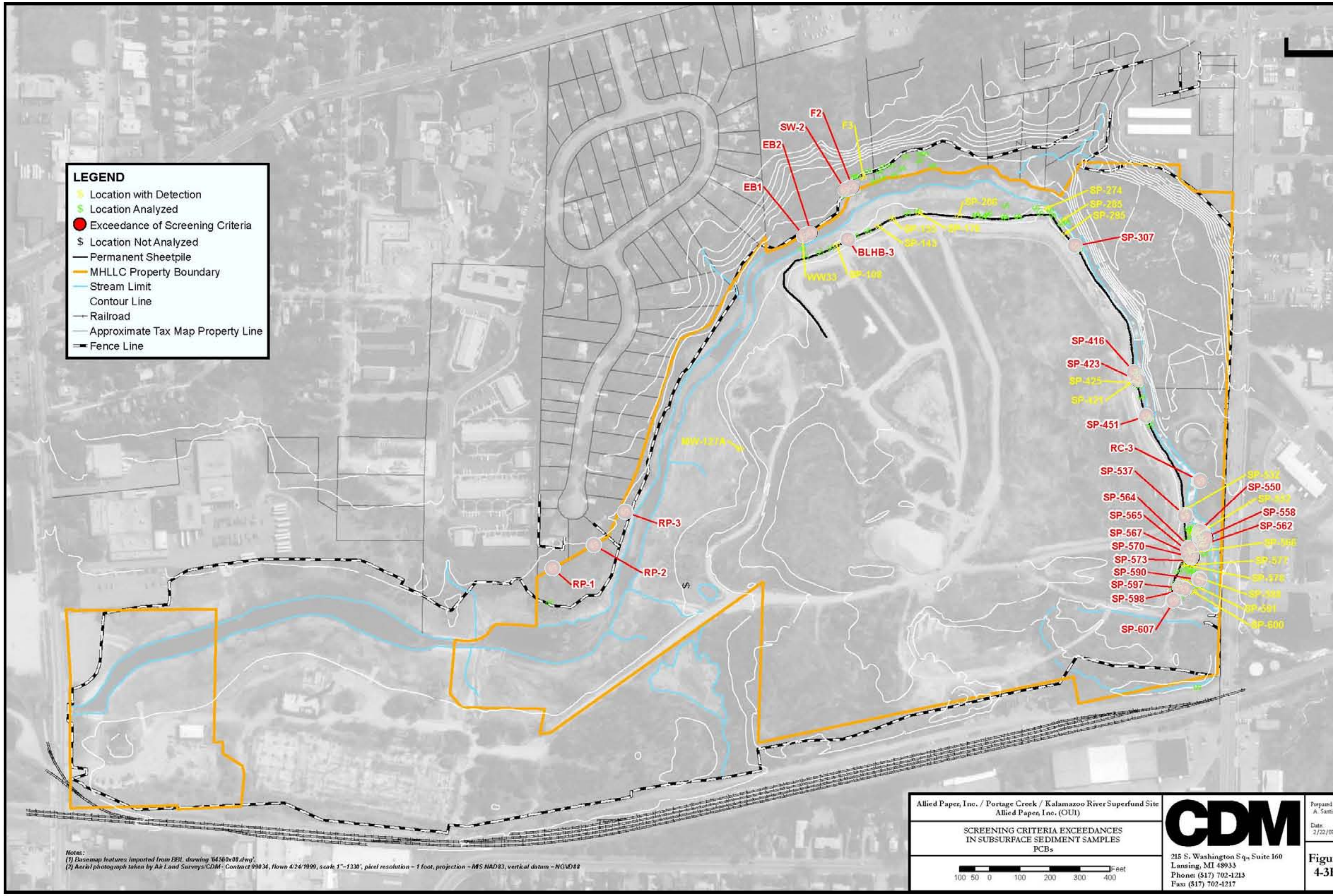
SURFACE SEDIMENT SAMPLES EXCEEDING USEPA PRGs FOR PCBs

ARCADIS

FIGURE
A4-3

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G03.CDR



Legend:

= Sample location meets sediment criterion and/or was addressed by TCRA or IRM.

Note:

1. Subsurface sediment is considered equivalent to soil,with a PCB PRG of 16 mg/kg.
2. Samples RP-1 and RP-2 were identified in the RI Report (MDEQ, 2008) both as subsurface sediment samples and as subsurface soil samples. The FS considers these samples to be subsurface soil samples (see Fig. A4-2).
3. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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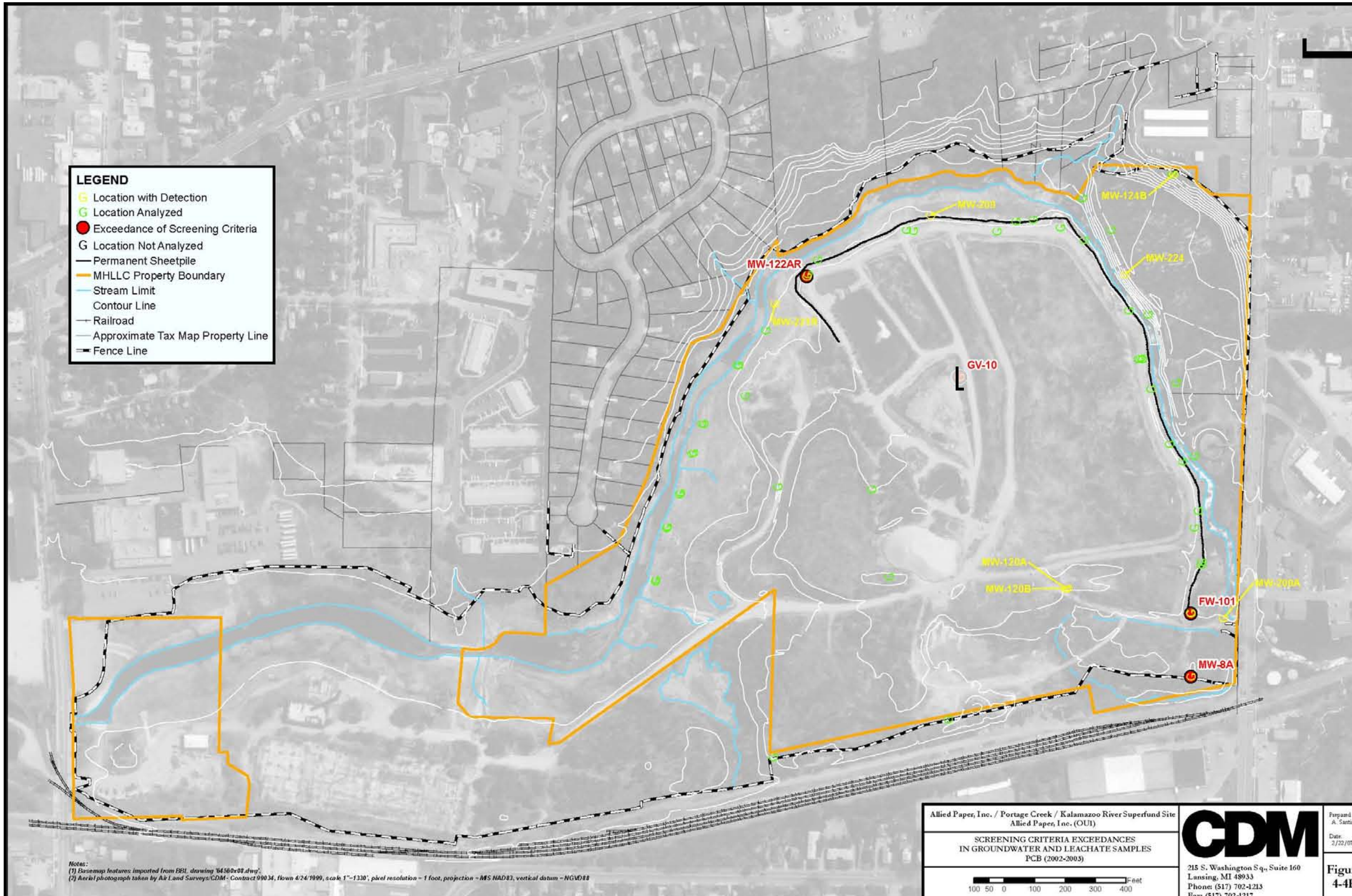
ALLIED PAPER, INC. OU

SUBSURFACE SEDIMENT SAMPLES EXCEEDING USEPA PRGs FOR PCBs

ARCADIS

FIGURE
A4-4

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G04.CDR



Legend:

1. L = Leachate sample.

Note:

1. USEPA PRG for PCBs in groundwater is 0.2 µg/L.
2. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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MILLENNIUM HOLDINGS LLC
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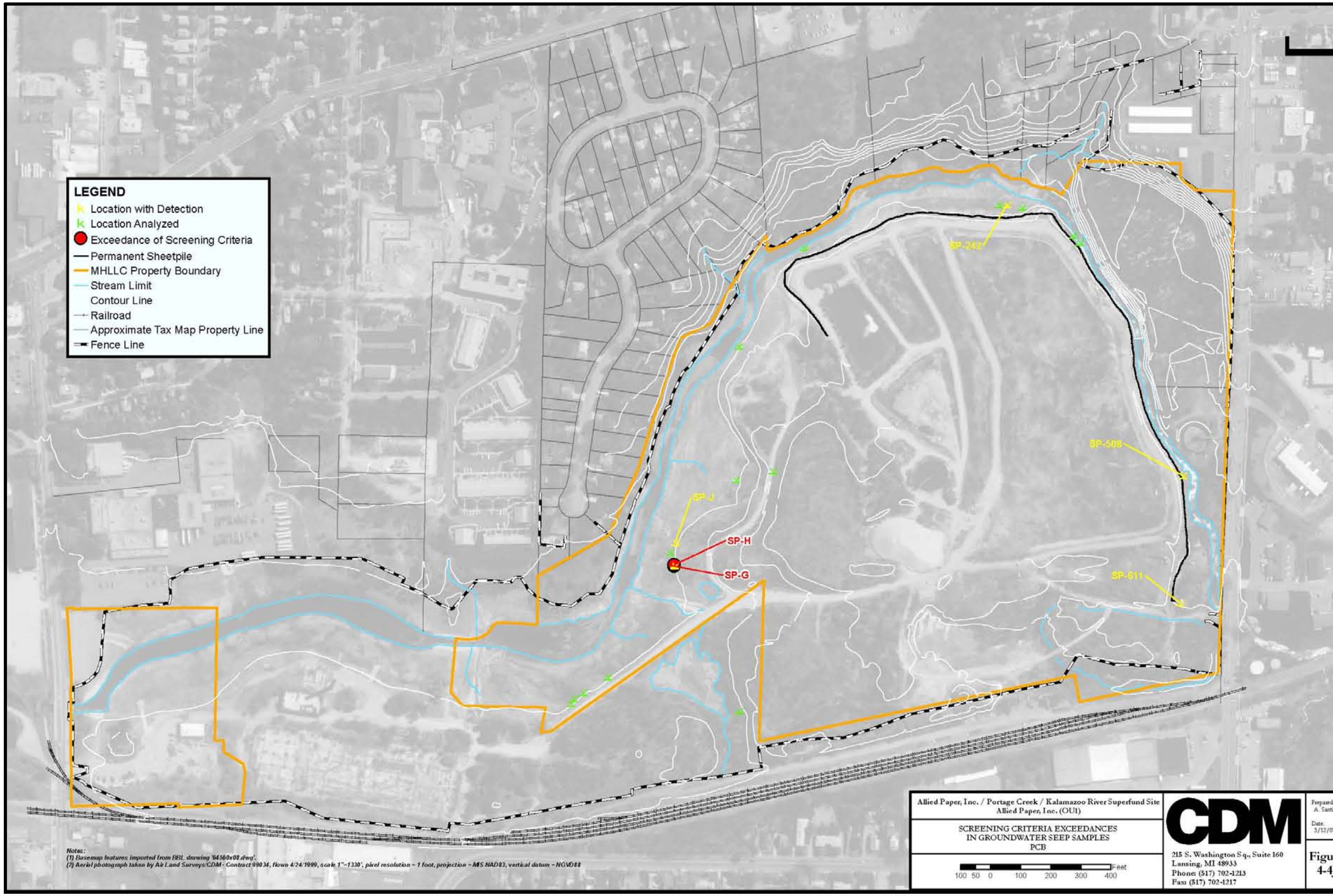
ALLIED PAPER, INC. OU

2002-2003
GROUNDWATER SAMPLES EXCEEDING
USEPA PRG FOR PCBs

ARCADIS

FIGURE
A4-5

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G05.CDR



Note:

1. USEPA PRG for PCBs in groundwater seeps is 0.2 µg/L.
2. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

DRAFT

MILLENNIUM HOLDINGS LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

2002-2003
GROUNDWATER SEEP SAMPLES
EXCEEDING USEPA PRGs FOR PCBs

ARCADIS

FIGURE
A4-6

10/21/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G06.CDR

ARCADIS

Attachment 5

Comparison of Remedial Investigation VOC, SVOC, and Inorganic Constituent Data to Screening Criteria

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Table A5-1 -- Comparison of Detected VOC Concentrations in Subsurface Soil and Residuals Samples to MDEQ Groundwater-Surface Water Interface Protection Criteria

Station ID	Constituent	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg)[1]	Groundwater-Surface Water Interface Protection Criteria (mg/kg)[2]	Exceedance (Y/N)	RI Report Data Source
Monarch HRDL							
MLSS-4	carbon tetrachloride	18-20	3.8	0.1	0.9	Y	Table 4-2B(CD)

Notes:
[1] RI Report screening criteria from Table 4-2H.
[2] Michigan Act 451 Part 201 groundwater-surface water interface protection criteria from MDEQ RRD Operational Memorandum 1, Commercial/Industrial Soil Generic Cleanup Levels and Screening Criteria.
RI Report - Remedial Investigation Report (MDEQ 2008)
mg/kg - milligrams per kilogram.
ft bgs - feet below ground surface.

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Feasibility Study Report

Table A5-2 -- Comparison of Detected SVOC Concentrations in Subsurface Soil and Residuals Samples to MDEQ Groundwater-Surface Water Interface Protection Criteria

Station ID	Constituent	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg)[1]	Groundwater-Surface Water Interface Protection Criteria (mg/kg)[2]	Exceedance (Y/N)	RI Report Data Source
Former Operational Areas							
Monarch HRDL							
MLSS-2	4-Methylphenol	20-22	2.1	1.4	1.4	Y	Table 4-2D(CD)
MLSS-3	4-Methylphenol	18-20	2.7	1.4	1.4	Y	Table 4-2D(CD)
MLSS-4	4-Methylphenol	18-20	4.7	1.4	1.4	Y	Table 4-2D(CD)
MLSS-5	naphthalene	22-24	1	0.87	0.9	Y	Table 4-2D(CD)
MLSS-5	4-Methylphenol	22-24	2.3	1.4	1.4	Y	Table 4-2D(CD)
Bryant HRDL/FRDLs							
BHDL-22[3]	4-Methylphenol	10-12	5.9-8.1	1.4	1.4	Y	Table 4-2D(CD)
BHDL-123[3]	phenanthrene	8-9.5	7.2-16	5.3	5.3	Y	Table 4-2D(CD)
DLHB-1	4-Methylphenol	14-16	2.7	1.4	1.4	Y	Table 4-2D(CD)
Western Disposal Area							
WA-1	pentachlorophenol	12-13	2.8	0.022	2.8	Y	Table 4-2D(CD)
WA-2	4-Methylphenol	12-14	1.5	1.4	1.4	Y	Table 4-2D(CD)
WA-5	4-Methylphenol	22-23.5	38	1.4	1.4	Y	Table 4-2D(CD)
WA-6	4-Methylphenol	12-13	1.7	1.4	1.4	Y	Table 4-2D(CD)
WA-7	4-Methylphenol	20-22	12	1.4	1.4	Y	Table 4-2D(CD)

Notes:
[1] RI Report screening criteria from Table 4-2H.
[2] Michigan Act 451 Part 201 groundwater-surface water interface protection criteria from MDEQ RRD Operational Memorandum 1, Commercial/Industrial Soil Generic Cleanup Levels and Screening Criteria.
[3] Multiple samples were analyzed at location. Range of detected concentrations is presented.
RI Report - Remedial Investigation Report (MDEQ 2008).
mg/kg - milligrams per kilogram.
ft bgs - feet below ground surface.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Feasibility Study Report

Table A5-3 -- Comparison of Detected Inorganics in Surficial Soil and Residuals Samples to MDEQ Soil Groundwater-Surface Water Interface Protection Criteria

Station ID	Constituents	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg)[1]	Groundwater-Surface Water Interface Protection Criteria (mg/kg)[2, 3]	Exceedance (Y/N)	RI Report Data Source
Former Type III Landfill							
MA-1	Cobalt	0-1.5	2.5	6.8	2	Y	Table 4-2G (CD)
MA-1	Manganese	0-1.5	180	440	79	Y	Table 4-2G (CD)
MA-4	Selenium	0-1.5	0.86	0.41	0.4	Y	Table 4-2G (CD)

Notes:

[1] RI Report screening criteria from Table 4-2F.

[2] Groundwater-surface water interface criteria from MDEQ RRD Operation Memorandum 1, Table 3 Soil: Industrial and Commercial Part 201 Generic Cleanup Criteria and Screening Levels.

[3] Groundwater-surface water interface protection criteria for manganese calculated using hardness value of 225 mg/L.

RI Report - Remedial Investigation Report (MDEQ 2008).

mg/kg - milligrams per kilogram.

mg/L - milligrams per liter

ft bgs - feet below ground surface.

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Table A5-4 -- Comparison of Detected Inorganics in Subsurface Soils and Residuals Samples to MDEQ Soil Groundwater-Surface Water Interface Protection Criteria

Station ID	Constituents	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg)[1]	Groundwater-Surface Water Interface Protection Criteria (mg/kg)[2, 3]	Exceedance (Y/N)	RI Report Data Source
MA-1	barium	3-4.5	1000	75	680	Y	Table 4-2H (CD)
B-7B	cobalt	10-12	2.2	6.8	2	Y	Table 4-2H (CD)
BHDL-123	cobalt	8-9.5	6.8	6.8	2	Y	Table 4-2H (CD)
BHDL-123	cobalt	10-12	5.7	6.8	2	Y	Table 4-2H (CD)
BHDL-22 [4]	cobalt	10-12	8.9-9.4	6.8	2	Y	Table 4-2H (CD)
BHDL-22 [4]	cobalt	12-14	4.1-5.4	6.8	2	Y	Table 4-2H (CD)
DLHB-2	cobalt	8-10	3.3	6.8	2	Y	Table 4-2H (CD)
DLHB-3	cobalt	8-10	4.1	6.8	2	Y	Table 4-2H (CD)
DLHB-6	cobalt	10-12	2.4	6.8	2	Y	Table 4-2H (CD)
FLF-1	cobalt	6-6.5	3.6	6.8	2	Y	Table 4-2H (CD)
FLF-1	cobalt	6.5-8	3.9	6.8	2	Y	Table 4-2H (CD)
MA-1	cobalt	3-4.5	7.5	6.8	2	Y	Table 4-2H (CD)
MA-4	cobalt	10-12	5.9	6.8	2	Y	Table 4-2H (CD)
MLSS-1	cobalt	15.5-18	3.2	6.8	2	Y	Table 4-2H (CD)
MLSS-2	cobalt	20-22	4.0	6.8	2	Y	Table 4-2H (CD)
MLSS-2	cobalt	22-24	5.1	6.8	2	Y	Table 4-2H (CD)
MLSS-3	cobalt	18-20	3.7	6.8	2	Y	Table 4-2H (CD)
MLSS-3	cobalt	20-22	5.4	6.8	2	Y	Table 4-2H (CD)
MW-120B	cobalt	18-19	6.4	6.8	2	Y	Table 4-2H (CD)
MW-120B	cobalt	19-20	3.2	6.8	2	Y	Table 4-2H (CD)
MW-121B	cobalt	16-17.5	2.6	6.8	2	Y	Table 4-2H (CD)
MW-125B	cobalt	18-19	3.4	6.8	2	Y	Table 4-2H (CD)
MW-125B	cobalt	19-20	3.1	6.8	2	Y	Table 4-2H (CD)
MW-126A	cobalt	14-16	6.9	6.8	2	Y	Table 4-2H (CD)
MW-8A	cobalt	12-12.5	7.1	6.8	2	Y	Table 4-2H (CD)
MW-8A	cobalt	12.5-14	4.8	6.8	2	Y	Table 4-2H (CD)
WA-2	cobalt	14-18	2.7	6.8	2	Y	Table 4-2H (CD)
WA-3	cobalt	14-16	2.2	6.8	2	Y	Table 4-2H (CD)
WA-4	cobalt	8-10	2.1	6.8	2	Y	Table 4-2H (CD)
WA-6	cobalt	12-13	8.4	6.8	2	Y	Table 4-2H (CD)

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Table A5-4 -- Comparison of Detected Inorganics in Subsurface Soils and Residuals Samples to MDEQ Soil Groundwater-Surface Water Interface Protection Criteria

Station ID	Constituents	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg)[1]	Groundwater-Surface Water Interface Protection Criteria (mg/kg)[2, 3]	Exceedance (Y/N)	RI Report Data Source
WA-6	cobalt	13-15	6.8	6.8	2	Y	Table 4-2H (CD)
WA-7	cobalt	20-22	2.6	6.8	2	Y	Table 4-2H (CD)
WA-7	cobalt	22-24	3.8	6.8	2	Y	Table 4-2H (CD)
WA-8	cobalt	10-12	5.8	6.8	2	Y	Table 4-2H (CD)
WA-8	cobalt	12-14	2.2	6.8	2	Y	Table 4-2H (CD)
MA-4	copper	12-14	150	32	103	Y	Table 4-2H (CD)
BHDL-123	cyanide	8-9.5	1.1	32	0.1	Y	Table 4-2H (CD)
BHDL-22 [4]	cyanide	10-12	54-110	32	0.1	Y	Table 4-2H (CD)
DLHB-1	cyanide	16-18	0.7	32	0.1	Y	Table 4-2H (CD)
DLHB-2	cyanide	8-10	0.22	32	0.1	Y	Table 4-2H (CD)
DLHB-6	cyanide	10-12	0.65	32	0.1	Y	Table 4-2H (CD)
FLF-1	cyanide	6-6.5	1.8	32	0.1	Y	Table 4-2H (CD)
MA-1	cyanide	3-4.5	0.53	32	0.1	Y	Table 4-2H (CD)
MLSS-2	cyanide	20-22	15	32	0.1	Y	Table 4-2H (CD)
MLSS-3	cyanide	18-20	2.3	32	0.1	Y	Table 4-2H (CD)
MLSS-3	cyanide	20-22	1.8	32	0.1	Y	Table 4-2H (CD)
MLSS-4	cyanide	18-20	6.5	32	0.1	Y	Table 4-2H (CD)
MLSS-5	cyanide	22-24	7.4	32	0.1	Y	Table 4-2H (CD)
MW-120B	cyanide	18-19	1.2	32	0.1	Y	Table 4-2H (CD)
MW-121B	cyanide	16-17.5	1.2	32	0.1	Y	Table 4-2H (CD)
MW-125B	cyanide	18-19	2.6	32	0.1	Y	Table 4-2H (CD)
MW-125B	cyanide	19-20	0.97	32	0.1	Y	Table 4-2H (CD)
MW-126A	cyanide	14-16	5.3	32	0.10	Y	Table 4-2H (CD)
MW-8A	cyanide	12-12.5	1.7	32	0.1	Y	Table 4-2H (CD)
WA-5	cyanide	22-23.5	0.29	32	0.1	Y	Table 4-2H (CD)
WA-6	cyanide	12-13	2.1	32	0.1	Y	Table 4-2H (CD)
WA-7	cyanide	20-22	0.36	32	0.1	Y	Table 4-2H (CD)
WA-7	cyanide	22-24	0.42	32	0.1	Y	Table 4-2H (CD)
WA-8	cyanide	10-12	0.68	32	0.1	Y	Table 4-2H (CD)
B-7B	manganese	10-12	89	440	78.7	Y	Table 4-2H (CD)

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Allied Paper, Inc. Operable Unit
Feasibility Study Report

Table A5-4 -- Comparison of Detected Inorganics in Subsurface Soils and Residuals Samples to MDEQ Soil Groundwater-Surface Water Interface Protection Criteria

Station ID	Constituents	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg)[1]	Groundwater-Surface Water Interface Protection Criteria (mg/kg)[2, 3]	Exceedance (Y/N)	RI Report Data Source
BHDL-123	manganese	10-12	3200	440	78.7	Y	Table 4-2H (CD)
BHDL-22 [4]	manganese	12-14	270-480	440	78.7	Y	Table 4-2H (CD)
DLHB-1	manganese	16-18	84	440	78.7	Y	Table 4-2H (CD)
DLHB-2	manganese	8-10	240	440	78.7	Y	Table 4-2H (CD)
DLHB-3	manganese	8-10	380	440	78.7	Y	Table 4-2H (CD)
DLHB-6	manganese	10-12	620	440	78.7	Y	Table 4-2H (CD)
FLF-1	manganese	6-6.5	190	440	78.7	Y	Table 4-2H (CD)
FLF-1	manganese	6.5-8	200	440	78.7	Y	Table 4-2H (CD)
MA-4	manganese	12-14	96	440	78.7	Y	Table 4-2H (CD)
MLSS-1	manganese	14-15.5	200	440	78.7	Y	Table 4-2H (CD)
MLSS-1	manganese	15.5-18	290	440	78.7	Y	Table 4-2H (CD)
MLSS-2	manganese	22-24	350	440	78.7	Y	Table 4-2H (CD)
MLSS-3	manganese	20-22	260	440	78.7	Y	Table 4-2H (CD)
MLSS-4	manganese	18-20	86	440	78.7	Y	Table 4-2H (CD)
MW-120B	manganese	19-20	150	440	78.7	Y	Table 4-2H (CD)
MW-125B	manganese	19-20	220	440	78.7	Y	Table 4-2H (CD)
MW-126A	manganese	14-16	360	440	78.7	Y	Table 4-2H (CD)
WA-1	manganese	12-13	180	440	78.7	Y	Table 4-2H (CD)
WA-2	manganese	14-18	350	440	78.7	Y	Table 4-2H (CD)
WA-3	manganese	16-18	220	440	78.7	Y	Table 4-2H (CD)
WA-6	manganese	12-13	370	440	78.7	Y	Table 4-2H (CD)
WA-6	manganese	13-15	400	440	78.7	Y	Table 4-2H (CD)
WA-7	manganese	22-24	240	440	78.7	Y	Table 4-2H (CD)
WA-8	manganese	12-14	500	440	78.7	Y	Table 4-2H (CD)
BHDL-123	mercury	8-9.5	2.8	0.13	0.1	Y	Table 4-2H (CD)
BHDL-22 [4]	mercury	10-12	4.4-5.1	0.13	0.1	Y	Table 4-2H (CD)
FLF-1	mercury	6-6.5	0.75	0.13	0.1	Y	Table 4-2H (CD)
MA-4	mercury	12-14	0.35	0.13	0.1	Y	Table 4-2H (CD)
MLSS-2	mercury	20-22	0.55	0.13	0.1	Y	Table 4-2H (CD)
MLSS-3	mercury	18-20	1.6	0.13	0.1	Y	Table 4-2H (CD)

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Allied Paper, Inc. Operable Unit
Feasibility Study Report

Table A5-4 -- Comparison of Detected Inorganics in Subsurface Soils and Residuals Samples to MDEQ Soil Groundwater-Surface Water Interface Protection Criteria

Station ID	Constituents	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg)[1]	Groundwater-Surface Water Interface Protection Criteria (mg/kg)[2, 3]	Exceedance (Y/N)	RI Report Data Source
MLSS-3	mercury	20-22	3.3	0.13	0.1	Y	Table 4-2H (CD)
MLSS-4	mercury	18-20	2.0	0.13	0.1	Y	Table 4-2H (CD)
MLSS-5	mercury	22-24	1.8	0.13	0.1	Y	Table 4-2H (CD)
MLSS-5	mercury	24-26	0.26	0.13	0.1	Y	Table 4-2H (CD)
MW-120B	mercury	18-19	0.24	0.13	0.1	Y	Table 4-2H (CD)
MW-120B	mercury	19-20	0.23	0.13	0.1	Y	Table 4-2H (CD)
MW-121B	mercury	16-17.5	1.0	0.13	0.1	Y	Table 4-2H (CD)
MW-125B	mercury	18-19	1.1	0.13	0.1	Y	Table 4-2H (CD)
MW-126A	mercury	14-16	0.59	0.13	0.05	Y	Table 4-2H (CD)
MW-8A	mercury	12-12.5	0.17	0.13	0.1	Y	Table 4-2H (CD)
MW-8A	mercury	12.5-14	0.11	0.13	0.1	Y	Table 4-2H (CD)
WA-1	mercury	12-13	1.3	0.13	0.1	Y	Table 4-2H (CD)
WA-1	mercury	13-14	0.19	0.13	0.1	Y	Table 4-2H (CD)
WA-6	mercury	12-13	0.38	0.13	0.1	Y	Table 4-2H (CD)
WA-8	mercury	10-12	0.14	0.13	0.1	Y	Table 4-2H (CD)
BHDL-22	selenium	12-14	0.43	0.41	0.4	Y	Table 4-2H (CD)
DLHB-3	selenium	8-10	0.48	0.41	0.4	Y	Table 4-2H (CD)
MA-1	selenium	3-4.5	0.81	0.41	0.4	Y	Table 4-2H (CD)
MA-4	selenium	3-4.5	1.8	0.41	0.4	Y	Table 4-2H (CD)
MLSS-1	selenium	14-15.5	0.43	0.41	0.4	Y	Table 4-2H (CD)
MLSS-2	selenium	22-24	0.95	0.41	0.4	Y	Table 4-2H (CD)
MLSS-3	selenium	20-22	0.76	0.41	0.4	Y	Table 4-2H (CD)
MW-120B	selenium	19-20	1.1	0.41	0.4	Y	Table 4-2H (CD)
MW-126A	selenium	14-16	0.53	0.41	0.4	Y	Table 4-2H (CD)
MW-8A	selenium	12.5-14	1.2	0.41	0.4	Y	Table 4-2H (CD)
WA-7	selenium	22-24	1.1	0.41	0.4	Y	Table 4-2H (CD)
BHDL-123	zinc	8-9.5	250	47	233.0	Y	Table 4-2H (CD)
BHDL-22 [4]	zinc	10-12	250-260	47	233.0	Y	Table 4-2H (CD)
MLSS-2	zinc	20-22	240	47	233.0	Y	Table 4-2H (CD)
MLSS-4	zinc	18-20	450	47	233.0	Y	Table 4-2H (CD)

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Allied Paper, Inc. Operable Unit
Feasibility Study Report

Table A5-4 -- Comparison of Detected Inorganics in Subsurface Soils and Residuals Samples to MDEQ Soil Groundwater-Surface Water Interface Protection Criteria

Station ID	Constituents	Depth (ft bgs)	Concentration (mg/kg)	RI Report Screening Criteria (mg/kg)[1]	Groundwater-Surface Water Interface Protection Criteria (mg/kg)[2, 3]	Exceedance (Y/N)	RI Report Data Source
MLSS-5	zinc	22-24	250	47	233.0	Y	Table 4-2H (CD)
MW-121B	zinc	16-17.5	550	47	233.0	Y	Table 4-2H (CD)
MW-125B	zinc	18-19	320	47	233.0	Y	Table 4-2H (CD)
MW-8A	zinc	12.5-14	270	47	233.0	Y	Table 4-2H (CD)
WA-6	zinc	12-13	270	47	233.0	Y	Table 4-2H (CD)

Notes:

[1] RI Report screening criteria from Table 4-2H.

[2] Groundwater-surface water interface criteria from MDEQ RRD Operation Memorandum 1, Table 3 Soil: Industrial and Commercial Part 201 Generic Cleanup Criteria and Screening Levels.

[3] Groundwater-surface water interface protection criteria for barium, copper, manganese, and zinc calculated using hardness value of 225 mg/L.

[4] Multiple samples were analyzed at location. Range of detected concentrations is presented.

RI Report - Remedial Investigation Report (MDEQ 2008).

mg/kg - micrograms per kilogram.

Millennium Holdings, LLC
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Allied Paper, Inc. Operable Unit
Feasibility Study Report

Table A5-5 -- Comparison of Detected Inorganics in Groundwater Samples to MDEQ Groundwater-Surface Water Interface Criteria

Station ID	Constituents	Concentration (µg/L)	RI Report Screening Criteria (µg/L)[1]	Groundwater-Surface Water Interface Criteria (µg/L)[2, 3]	Exceedance (Y/N)	RI Report Data Source
MW-1	Zinc	2500	235	235	Y	Table 4-3C(CD)
MW-10	Zinc	710	235	235	Y	Table 4-3C(CD)
MW-124A [4]	Nickel	150-160	100	103	Y	Table 4-3C(CD)
MW-124B	Nickel	110	100	103	Y	Table 4-3C(CD)
MW-125A	Silver	1.7	0.2	0.2	Y	Table 4-3C(CD)
MW-16B	Cyanide	12	5.2	5.2	Y	Table 4-3C(CD)
MW-16B	Zinc	240	235	235	Y	Table 4-3C(CD)
MW-220	Cyanide	19	5.2	5.2	Y	Table 4-3C(CD)
MW-221R [4]	Cyanide	13-22	5.2	5.2	Y	Table 4-3C(CD)
MW-224	Barium	1300	1037	1037	Y	Table 4-3C(CD)
MW-226	Barium	1700	1037	1037	Y	Table 4-3C(CD)
MW-228	Manganese	5300	50	3900	Y	Table 4-3C(CD)
MW-229	Manganese	6200	50	3900	Y	Table 4-3C(CD)
MW-24R	Nickel	110	100	103	Y	Table 4-3C(CD)
MW-6 [4]	Zinc	530-1400	235	235	Y	Table 4-3C(CD)
MW-7	Zinc	1000	235	235	Y	Table 4-3C(CD)
MW-9	Zinc	5300	235	235	Y	Table 4-3C(CD)

Notes:

[1] RI Report screening criteria from Table 4-4D.

[2] Groundwater-surface water interface criteria from MDEQ RRD Operation Memorandum 1, Table 1 Groundwater Residential, Industrial and Commercial Part 201 Generic Cleanup Criteria and Screening Levels.

Millennium Holdings, LLC
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Table A5-6 -- Comparison of Detected Inorganics in Groundwater Seep Samples to MDEQ Groundwater-Surface Water Interface Criteria

Station ID	Study Area	Constituent	Concentration (µg/L)	RI Report Screening Criteria (µg/L)[1]	Groundwater-Surface Water Interface Criteria (µg/L)[2, 3]	Updated Screening Criteria (µg/L)	Exceedance (Y/N)	RI Report Data Source
SP-611 [4]	Operational Areas	Barium	1100-1500	1037	1000	1037	Y	Table 4-4C (CD)
SP-611	Operational Areas	Selenium	5.2	5.0	5.0	5.0	Y	Table 4-4C (CD)
SP-J [4]	Former Type III Landfill	Barium	1300-1400	1037	1000	1037	Y	Table 4-4C (CD)
SP-N [4]	Former Type III Landfill	Cyanide	10-13	5.0	5.2	5.2	Y	Table 4-4C (CD)

Notes:

[1] RI Report screening criteria from Table 4-4J.

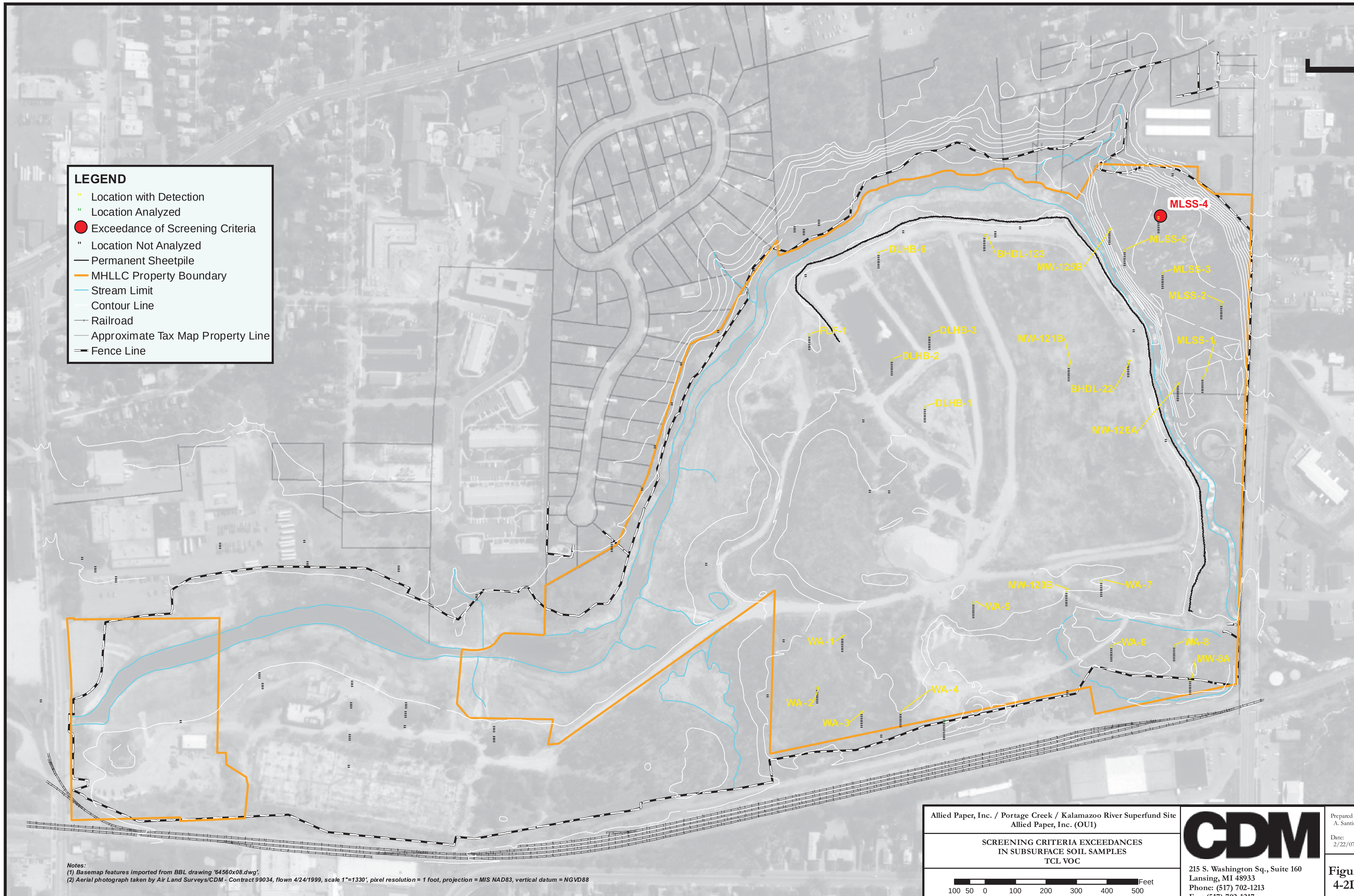
[2] Groundwater-surface water interface criteria from MDEQ RRD Operation Memorandum 1, Table 1 Groundwater Residential, Industrial and Commercial Part 201 Generic Cleanup Criteria and Screening Levels.

[3] Groundwater-surface water interface criteria for barium calculated using a hardness value of 225 mg/L.

[4] Multiple samples were analyzed at location. Range of detected concentrations are presented.

RI Report - Remedial Investigation Report (MDEQ 2008).

µg/L - milligrams per liter.



Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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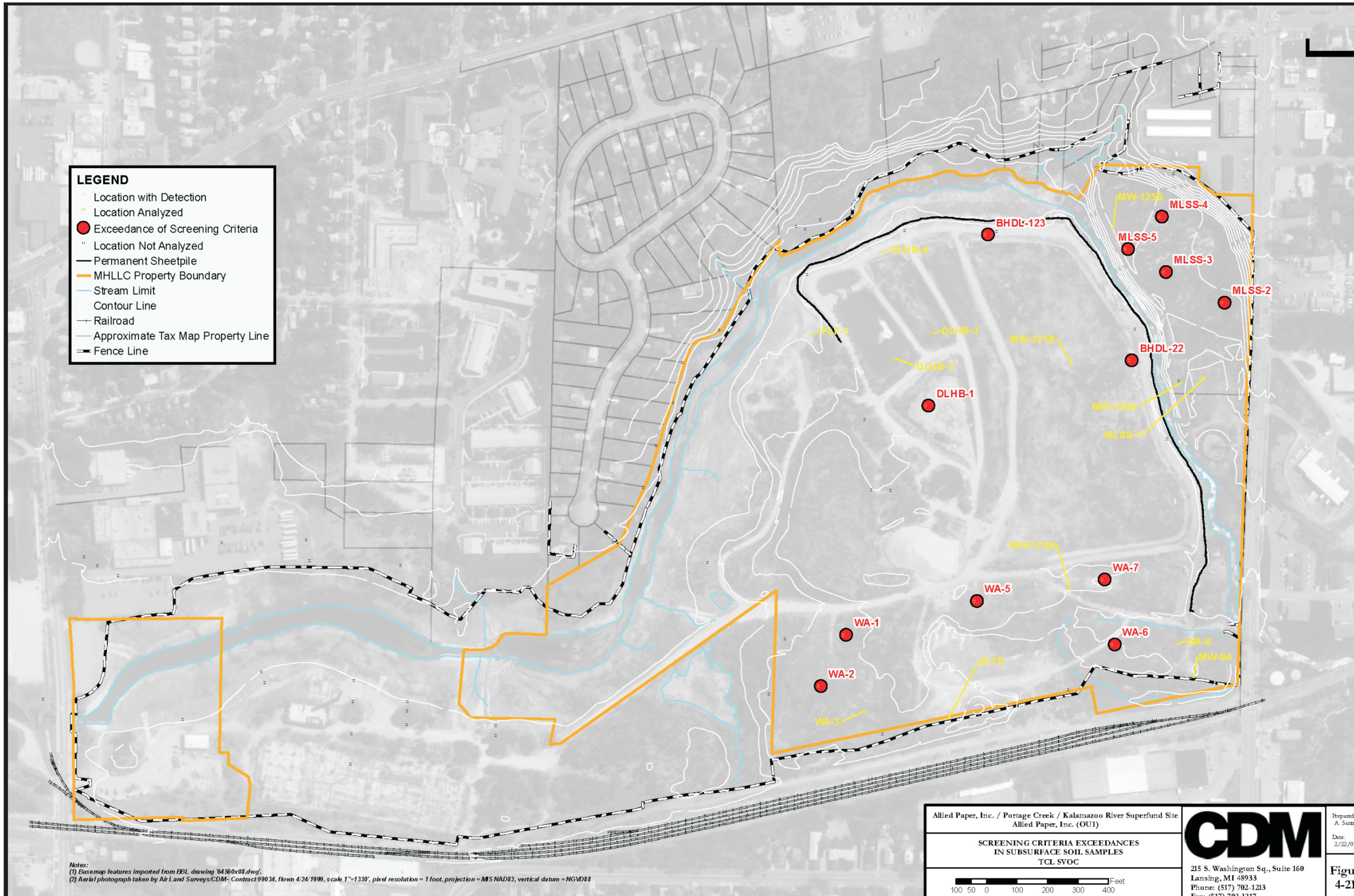
MILLENNIUM HOLDINGS LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

SUBSURFACE SOIL AND RESIDUALS SAMPLES EXCEEDING VOC GSI PROTECTION CRITERIA

ARCADIS

FIGURE
A5-1

10/14/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G071.CDR



Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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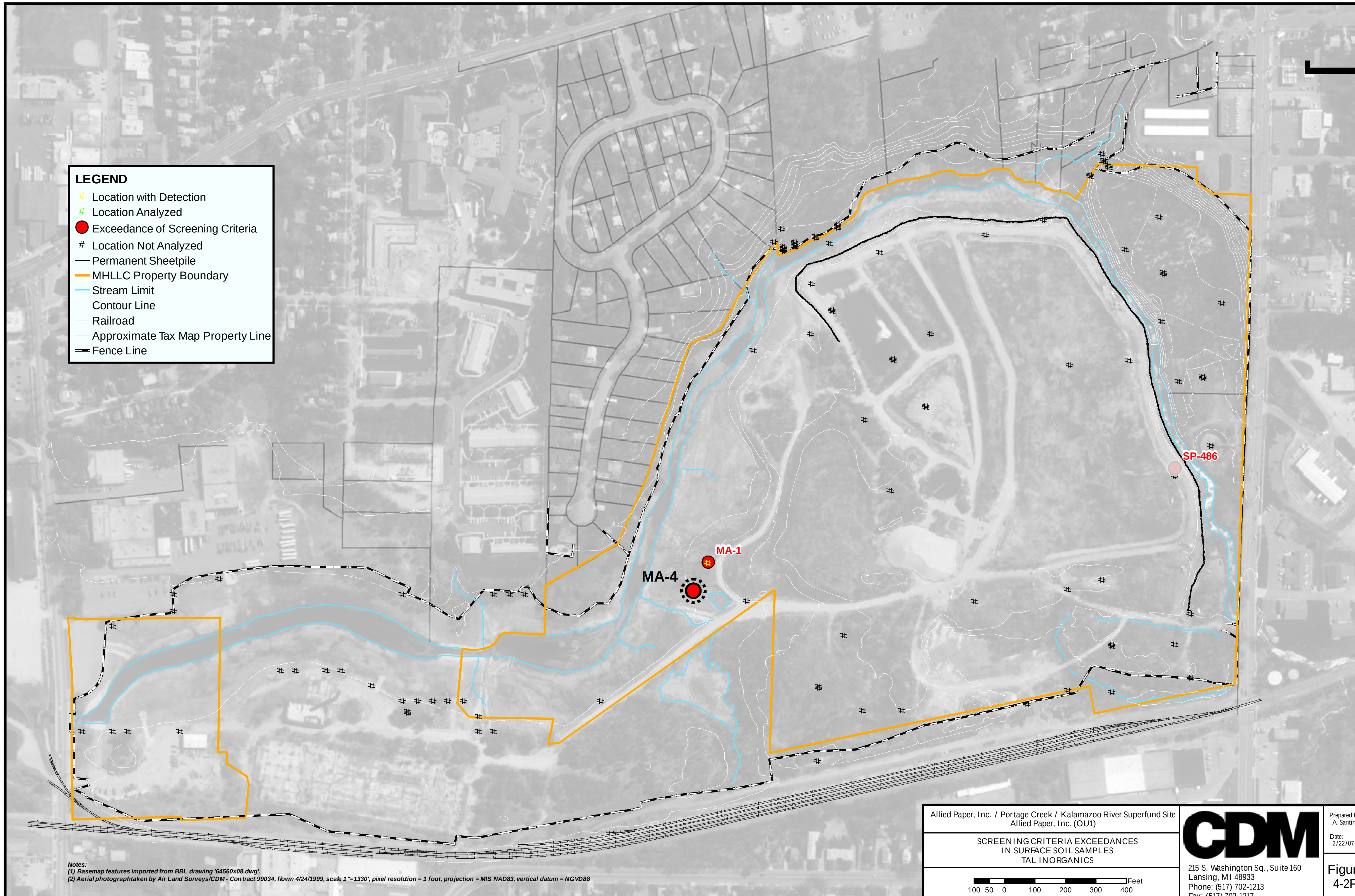
MILLENNIUM HOLDINGS LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

SUBSURFACE SOIL AND RESIDUALS SAMPLES EXCEEDING TCL SVOC GSI PROTECTION CRITERIA

ARCADIS

FIGURE
A5-2

10/22/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G08.CDR



Legend:

= Sample re-classified as subsurface soil sample.

= Newly identified location of exceedance.

Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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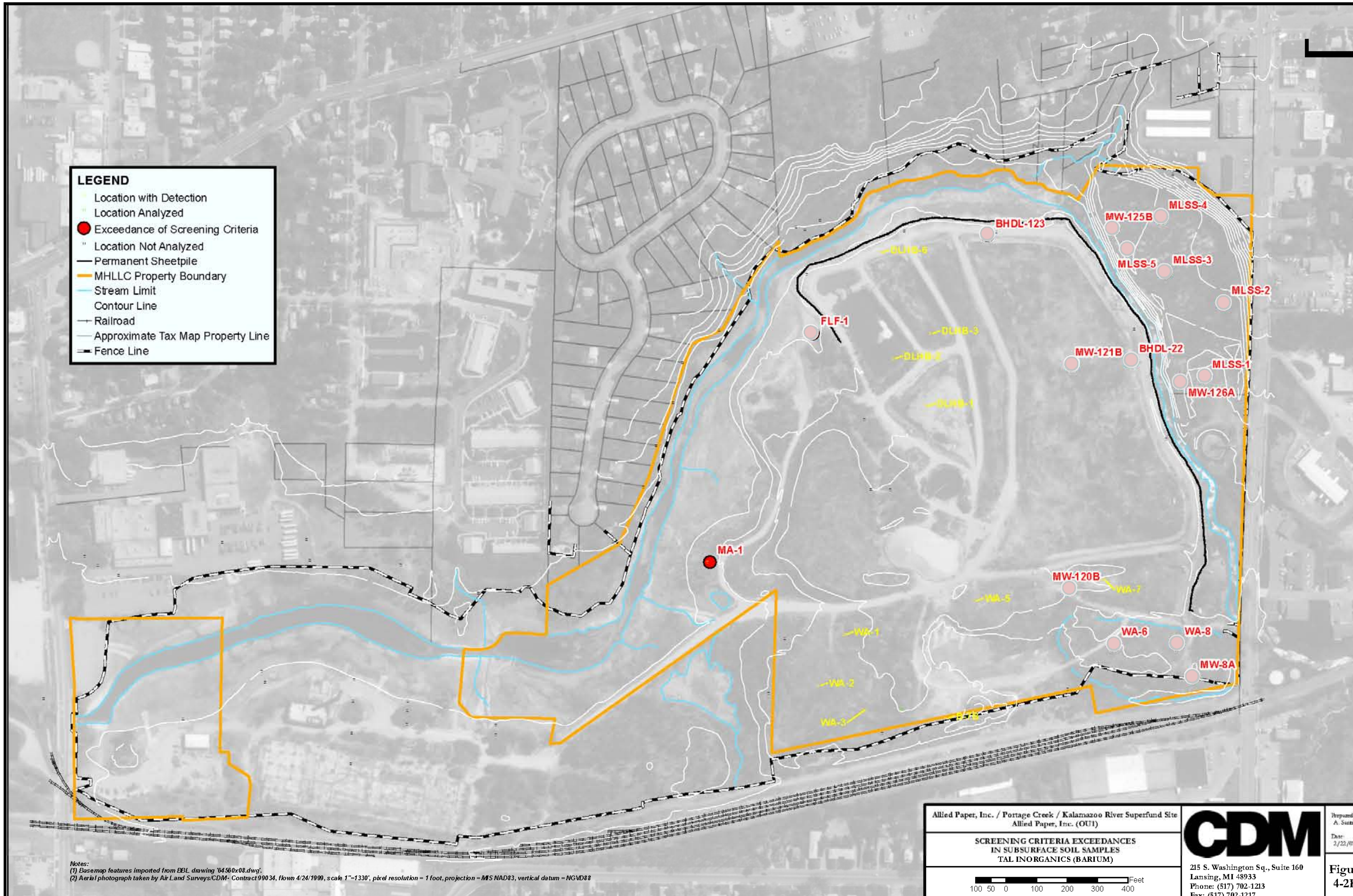
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

SURFACE SOIL SAMPLES EXCEEDING TAL INORGANICS GSI PROTECTION CRITERIA

ARCADIS

FIGURE
A5-3

10/14/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G09.CDR



Legend:

= Sample location meets barium groundwater-surface water interface protection criterion of 680 mg/kg.

Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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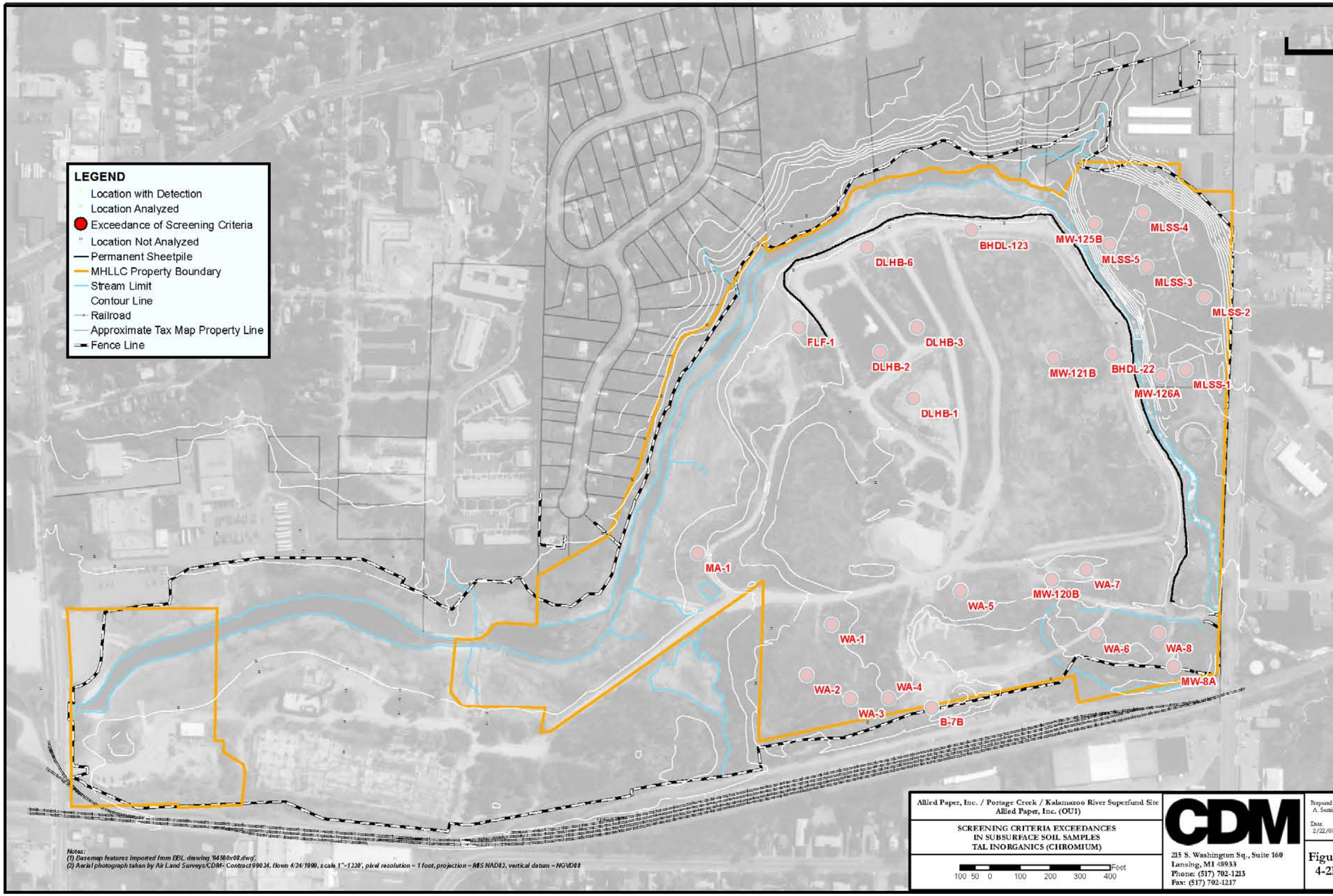
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

SUBSURFACE SOIL AND RESIDUALS SAMPLES EXCEEDING TAL INORGANICS GSI PROTECTION CRITERIA (BARIUM)

ARCADIS

FIGURE
A5-4

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G11.CDR



Legend:

= Sample location meets barium groundwater-surface water interface protection criterion of 4,147,000 mg/kg.

Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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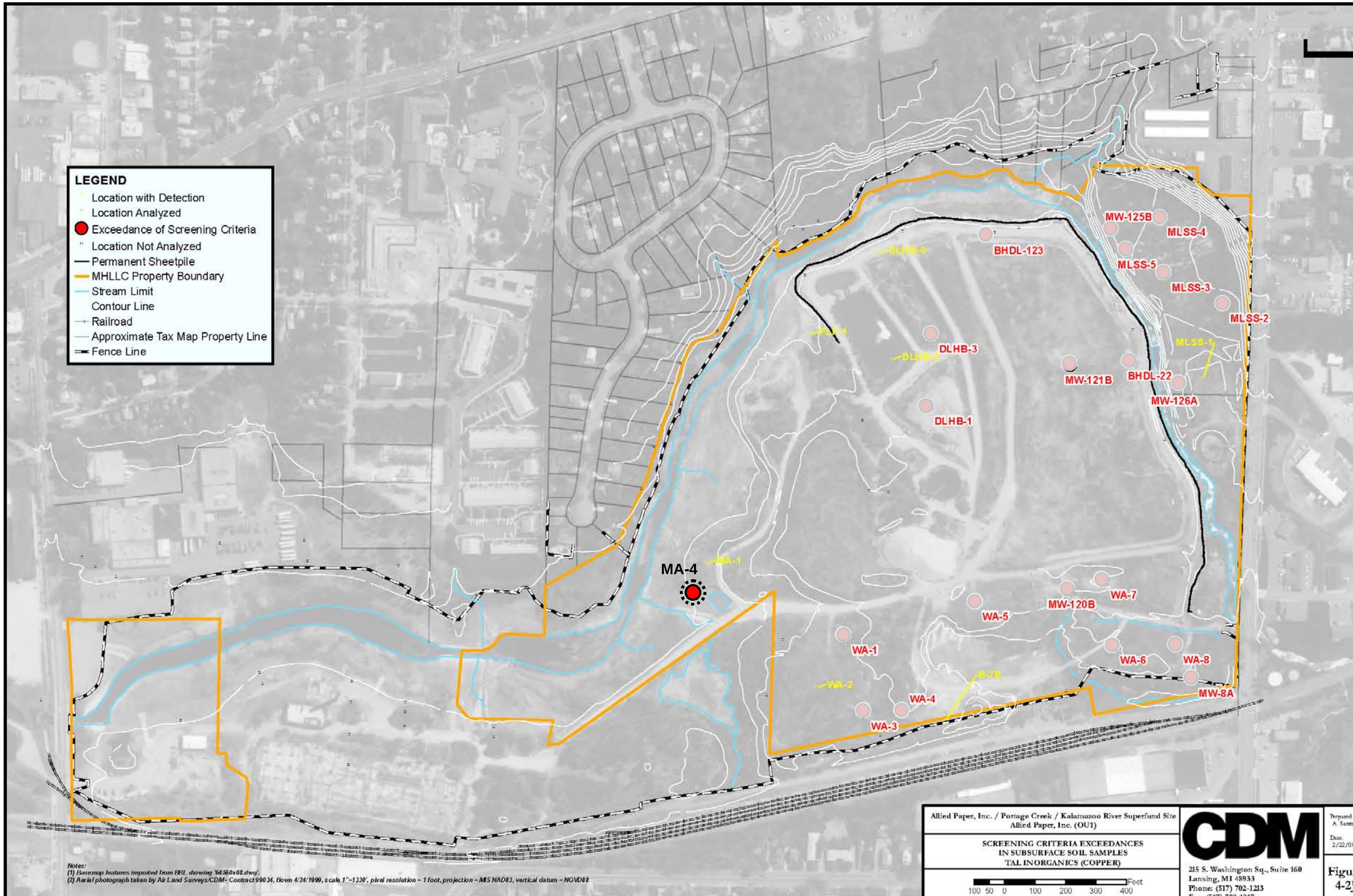
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

SUBSURFACE SOIL AND RESIDUALS SAMPLES EXCEEDING TAL INORGANICS GSI PROTECTION CRITERIA (CHROMIUM)

ARCADIS

FIGURE
A5-5

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G12.CDR



Legend:

= Sample location meets copper groundwater-surface water interface protection criterion of 130 mg/kg.

= Newly-identified location of exceedance of copper groundwater-surface water interface protection criterion of 103 mg/kg.

Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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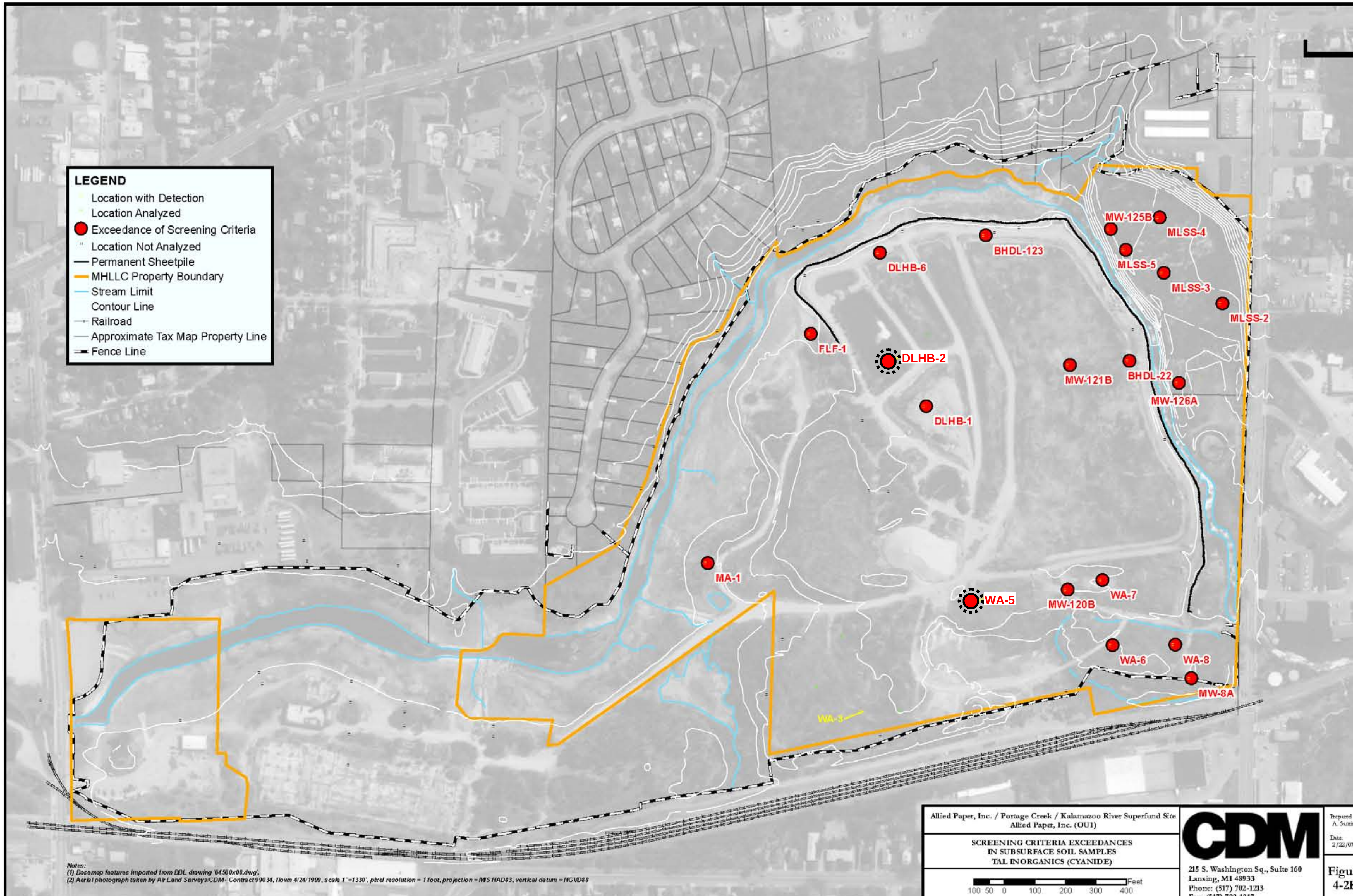
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

SUBSURFACE SOIL AND RESIDUALS SAMPLES EXCEEDANCES TAL INORGANICS GSI PROTECTION CRITERIA (COPPER)

ARCADIS

FIGURE
A5-6

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G13.CDR



Legend:

= Newly-identified location of exceedance of cyanide groundwater-surface water criterion of 0.1 mg/kg.

Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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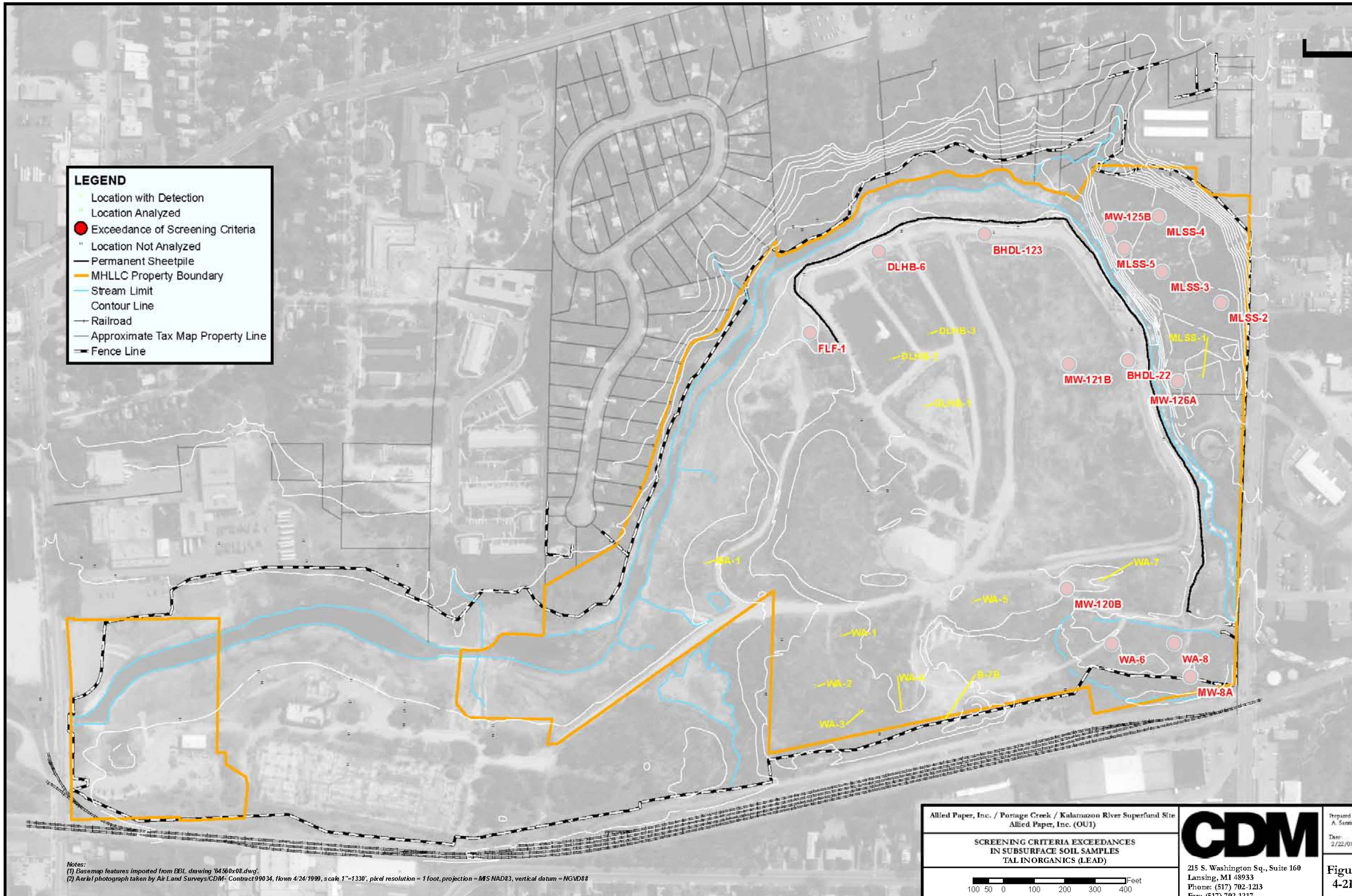
ALLIED PAPER, INC. OU

SUBSURFACE SOIL AND RESIDUALS SAMPLES EXCEEDING TAL INORGANICS GSI PROTECTION CRITERIA (CYANIDE)

ARCADIS

FIGURE
A5-7

10/14/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G14.CDR



Legend:

● = Sample location meets lead groundwater-surface water interface protection criterion of 4,300 mg/kg.

Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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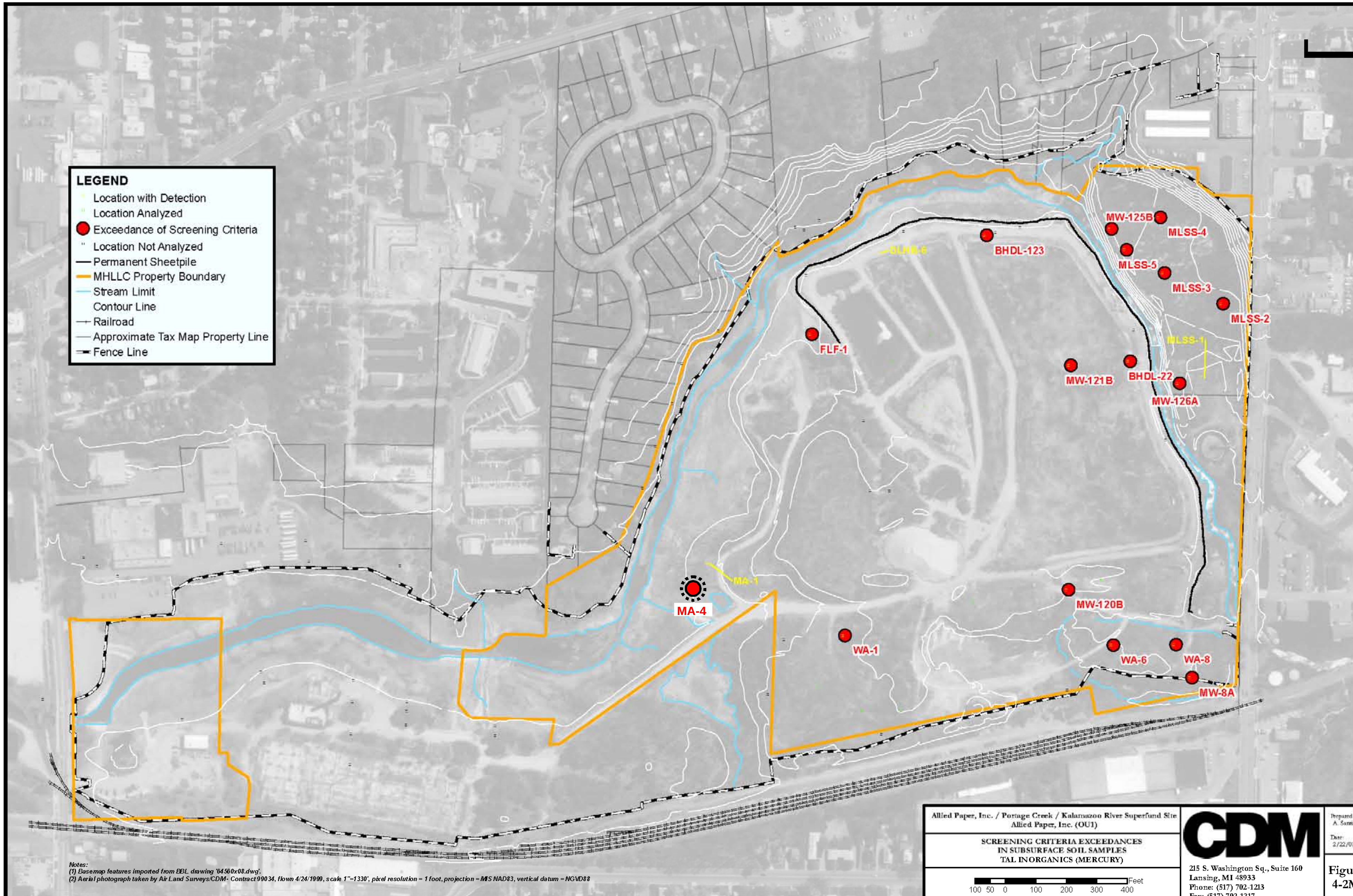
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

SUBSURFACE SOIL AND RESIDUALS SAMPLES EXCEEDING TAL INORGANICS GSI PROTECTION CRITERIA (LEAD)

ARCADIS

FIGURE
A5-8

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G15.CDR



Legend:

= Newly identified location of exceedance of mercury groundwater-surface water interface protection criterion of 0.1 mg/kg.

Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE

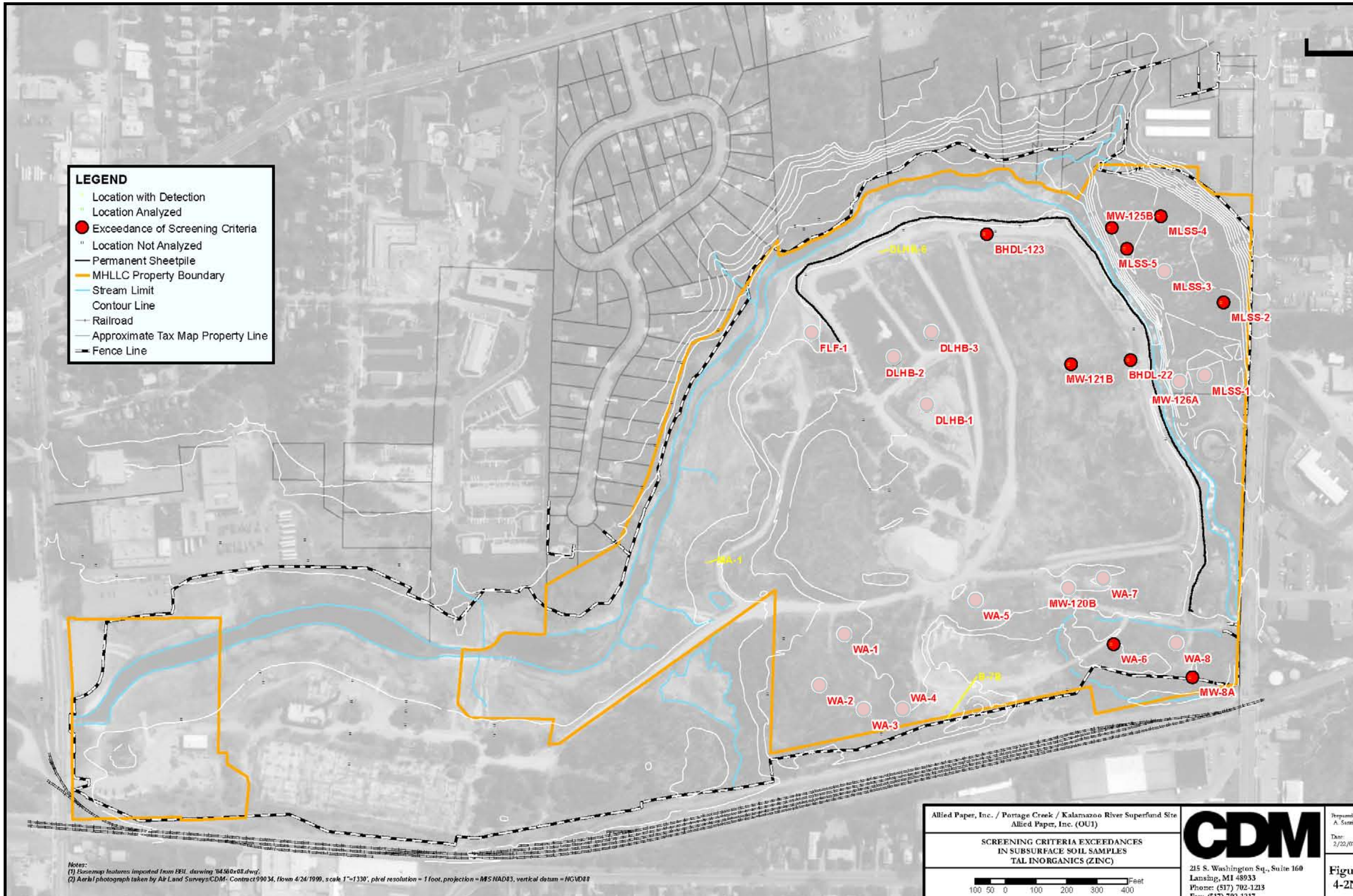
ALLIED PAPER, INC. OU

SUBSURFACE SOIL AND RESIDUALS SAMPLES EXCEEDING TAL INORGANICS GSI PROTECTION CRITERIA (MERCURY)

ARCADIS

FIGURE
A5-9

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G16.CDR



Legend:

= Sample location meets zinc groundwater-surface water interface protection criterion of 233 mg/kg.

Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

MILLENNIUM HOLDINGS LLC
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KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

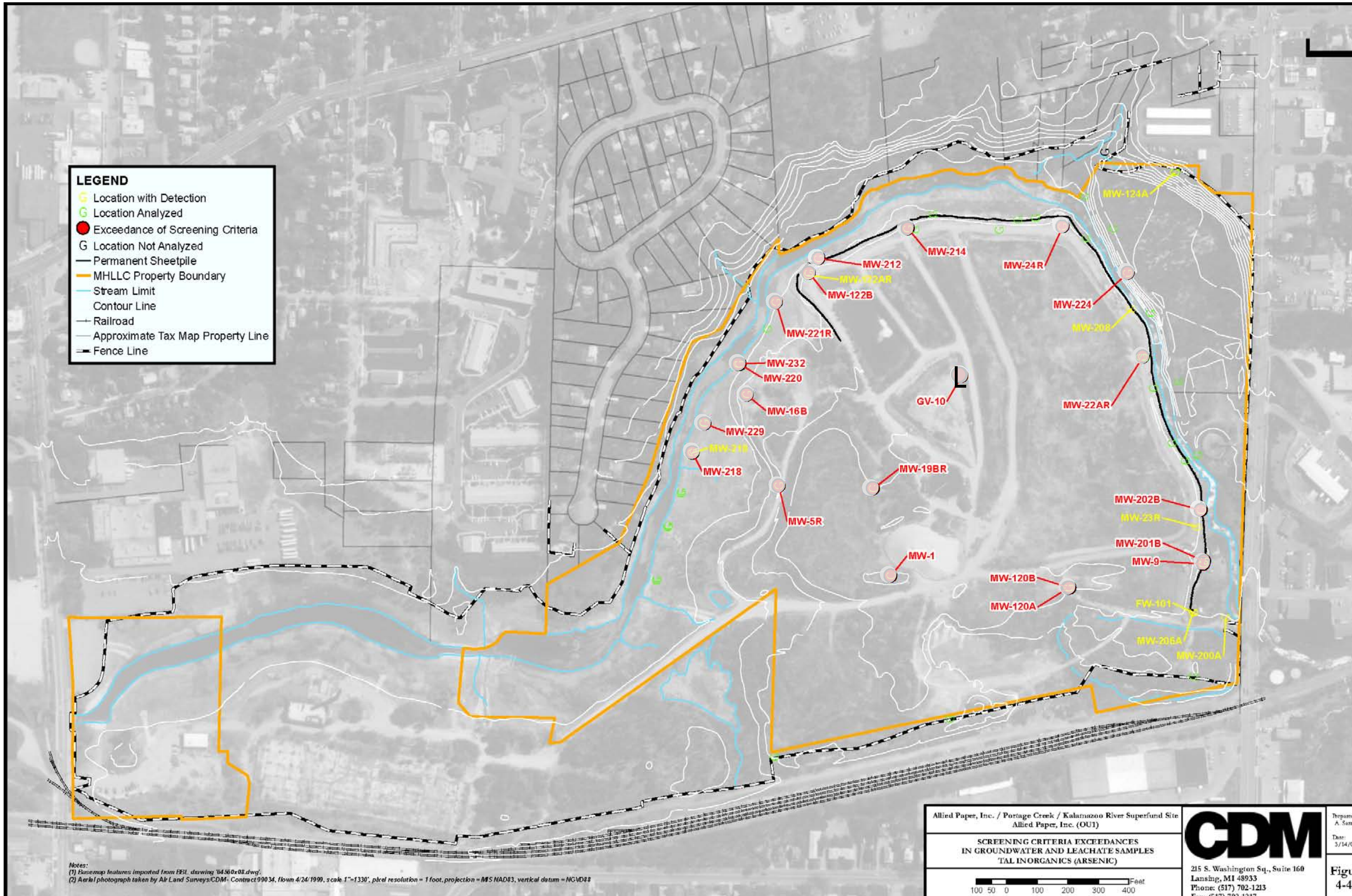
SUBSURFACE SOIL AND RESIDUALS SAMPLES EXCEEDING TAL INORGANICS GSI PROTECTION CRITERIA (ZINC)

DRAFT

ARCADIS

FIGURE
A5-10

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G32.CDR



Legend:

= Sample location meets arsenic groundwater-surface water interface criterion of 150 µg/L.

L = Leachate sample.

Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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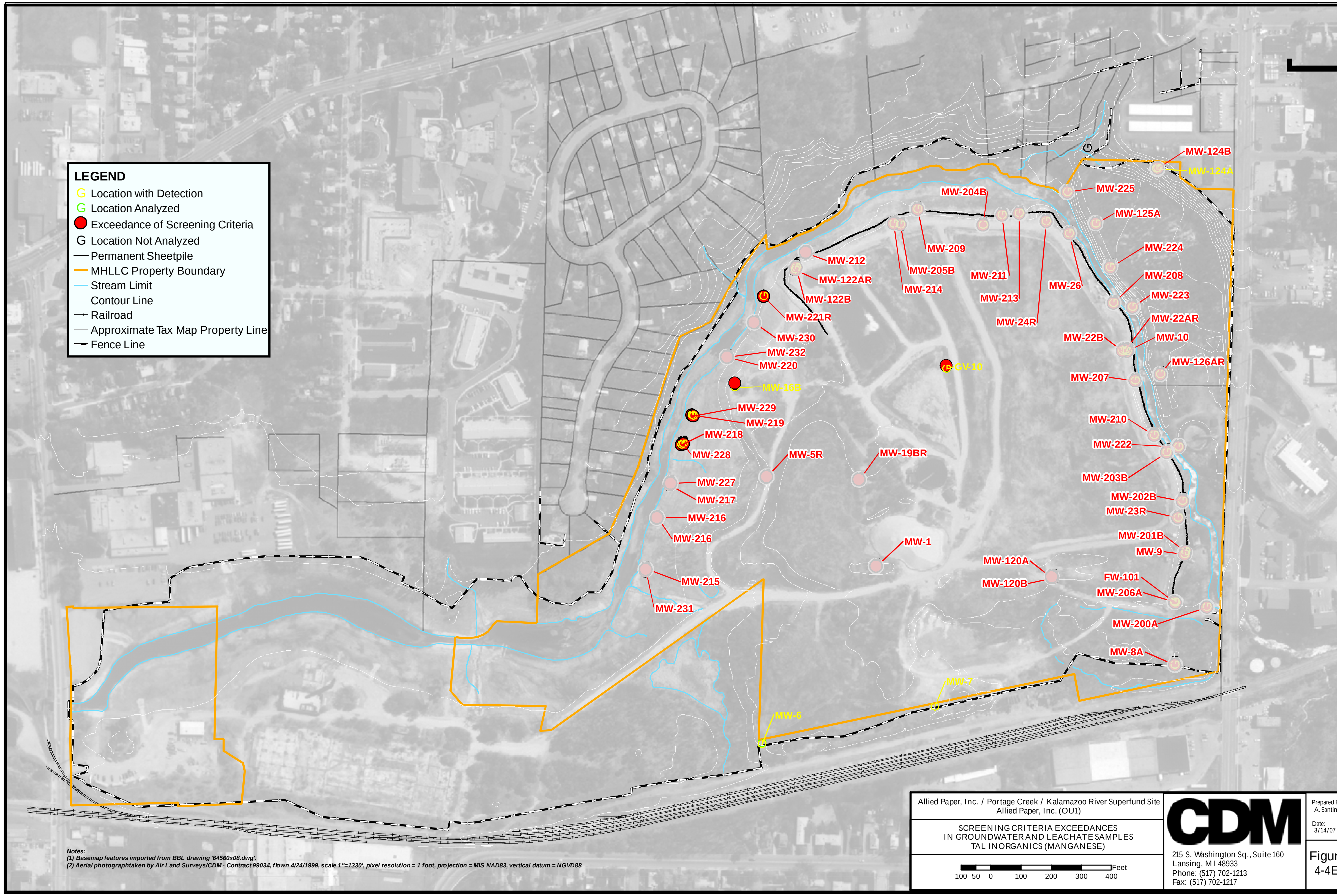
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GROUNDWATER SAMPLES EXCEEDING TAL INORGANICS GSI CRITERIA (ARSENIC)

ARCADIS

FIGURE
A5-11

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G26.CDR



Legend:

● = Sample location meets manganese groundwater-surface water interface criterion of 3,900 µg/L.

Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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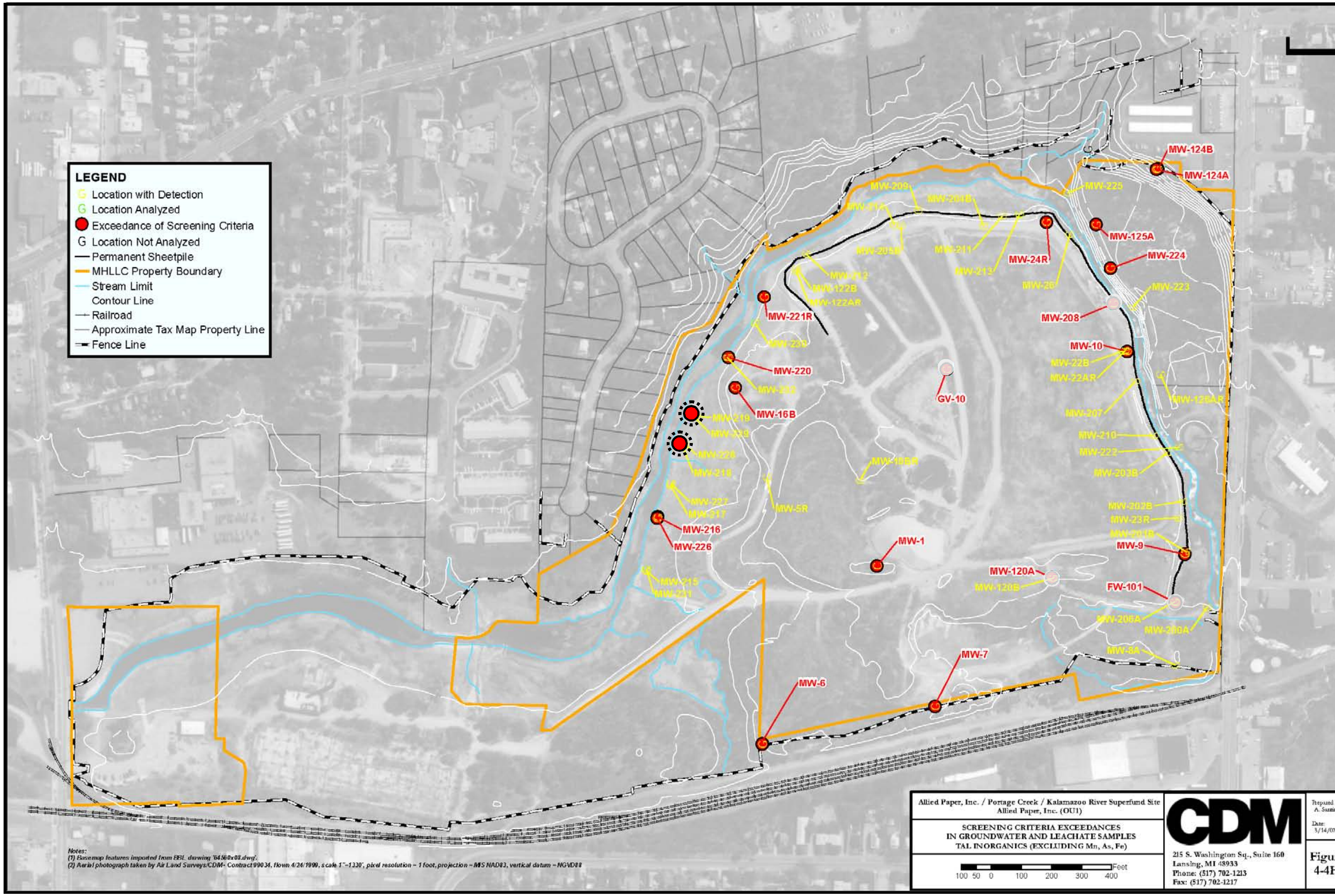
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GROUNDWATER SAMPLES EXCEEDING TAL INORGANICS GSI CRITERIA (MANGANESE)

ARCADIS

FIGURE
A5-12

10/14/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G25.CDR



Legend:

= Sample location meets inorganic constituent groundwater-surface water interface criteria.

= Newly identified location of exceedance of mercury groundwater-surface water interface protection criterion.

Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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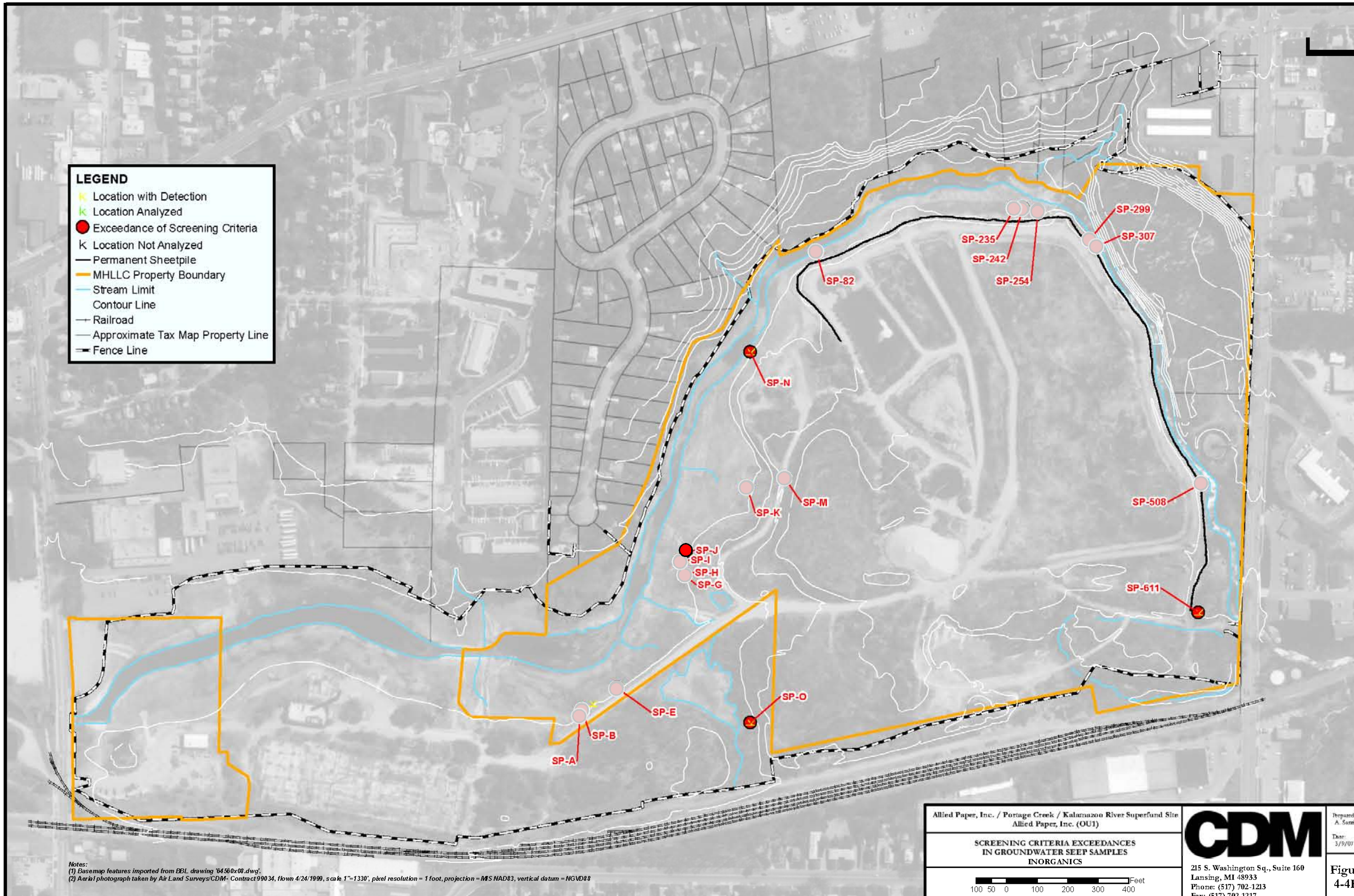
MILLENNIUM HOLDINGS LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GROUNDWATER SAMPLES EXCEEDING TAL INORGANICS GSI CRITERIA (EXCLUDING Mn, As, Fe)

ARCADIS

FIGURE
A5-13

10/23/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G28.CDR



Legend:

= Sample location meets inorganic constituent groundwater-surface water interface criteria.

Note:

1. Source file is from RI Report (MDEQ, 2008) prepared by Camp Dresser McKee on behalf of the Michigan Department of Environmental Quality.

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MILLENNIUM HOLDINGS LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GROUNDWATER SEEP SAMPLES EXCEEDING INORGANICS GSI CRITERIA

ARCADIS

FIGURE
A5-14

10/14/09 SYRACUSE-141ENV-DJHOWES, K.SARTORI
B0064587/0001/00002/CDR/64587G31.CDR

ARCADIS

Attachment 6

Risk Analysis for Site Workers and Truck Drivers

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Feasibility Study Report

Table A6-1 -- Fatality Risks Related to Onsite Components of Remedial Alternatives

	Alternative 5A [1]	**Alternative 5B [1]**	**Alternative 6 [2]**
	Total Removal and Offsite Disposal (without immobilization), Sheetpile Removal and Institutional Controls	Total Removal and Offsite Disposal (with immobilization), Sheetpile Removal and Institutional Controls	Hazardous Waste Landfill Containment, Sheetpile Removal and Institutional Controls
Expected Number of Fatalities at OU [3], u = AIR x TH	0.0090	0.0090	0.0369
Probability of at least 1 Fatality Occuring at OU [4]	0.0089	0.0089	0.0362
	1 in 112 chance	1 in 112 chance	1 in 28 chance
Average Incidence Rate (fatalities/hour), AIR	1.1E-07		
Incidence Rate of Fatalities (fatalities/hour) [5]			
2006	1.1E-07		
2007	1.0E-07		
2008	1.0E-07		
Total Hours Worked at OU [6], TH = AH x Y	85,000	85,000	350,000
Remedy Period (years), Y	5	5	10
Annual Worker Hours during Remedy Period [7], AH = W x 2000	17,000	17,000	35,000
Annual Average Number of Workers at OU [8], W	8.5	8.5	17.5

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Feasibility Study Report

Table A6-1 -- Fatality Risks Related to Onsite Components of Remedial Alternatives

Notes:

[1] Alternatives 5A and 5B primarily involve digging and hauling soils offsite. From 7 to 10 remediation workers (full-time equivalents) are expected to be onsite over the duration of the project (average of 8.5 workers).

[2] Alternative 6 involves excavating and relocating soils onsite and backfilling. From 10 to 25 remediation workers (full-time equivalents) are expected to be onsite over the duraiton of the project (average of 17.5 workers).

[3] Expected Number of Fatalities at OU (u) = Average Incidence Rate (AIR) x Total Hours worked at OU (TH)

[4] Probability of fatality occuring during onsite components of remedial alternatives is calculated using the Poisson distribution methodology

$$\boxed{f(x) = (e^{-u} * u^{x}) / x!}$$

where x = the number of fatalities and u = the expected number of fatalities during the remedy period.

The probability of experiencing at least one fatality during the remedy period is then

$$\boxed{f(x \geq 1) = 1 - f(0) = 1 - e^{-u}}$$

[5] Source: U.S. Department of Labor, Bureau of Labor Statistics, Census of Fatal Occupational Injuries, Fatal Occupational Injuries, total hours worked, and rates of fatal occupational injuries by selected worker characteristics, occupations, and industries, civilian workers. Rates provided for Waste Management and Remediation Services occupation class (NAICS Code 562). Rates converted from fatalities per 200,000,000 hours to fatalities per hour. Hours-based rates available only for 2006 and later.

[6] Total Hours Worked at OU (worker hours) = Annual Average Number of Workers at OU x Work hours per year (2,000 hours/year) x Duration of Project (years)

[7] Annual worker hours during remedy period (worker hours/year) = annual average number of full-time workers at OU x 2,000 hours/year. The 2,000 hours/year represents a full-time equivalent (40 hours/week x 50 weeks/year).

[8] Annual average number of workers is an estimate of the number of full-time equivalent workers expected to work at the OU each year during implementation of the remedial alternative. The number of workers and/or full-time equivalents may vary according to selected contractor's proposed workplan and sequencing approach.

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Table A6-2 -- Injury Risks Related to Onsite Components of Remedial Alternatives

	Alternative 5A [1]	**Alternative 5B** [1]	**Alternative 6** [2]
	Total Removal and Offsite Disposal (without immobilization), Sheetpile Removal and Institutional Controls	Total Removal and Offsite Disposal (with immobilization), Sheetpile Removal and Institutional Controls	Hazardous Waste Landfill Containment, Sheetpile Removal and Institutional Controls
Expected Number of Injuries or Illnesses at OU [3], u = AIR x TH	3.1	3.1	13
Probability of at least 1 Injury or Illness Occurring at OU [4]	0.95	0.95	1.00
	Near certainty	Near certainty	Near certainty
Average Incidence Rate (injuries and illnesses/hour), AIR	3.6E-05		
Incidence Rate of Nonfatal Injuries and Illnesses (injuries and illnesses/hour) [5]			
2003	4.2E-05		
2004	3.8E-05		
2005	3.6E-05		
2006	3.3E-05		
2007	3.2E-05		
Total Hours Worked at OU [6], TH = AH x Y	85,000	85,000	350,000
Remedy Period (years), Y	5	5	10
Annual Worker Hours during Remedy Period [7], AH = W x 2000	17,000	17,000	35,000
Annual Average Number of Workers at OU [8], W	8.5	8.5	17.5

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Table A6-2 -- Injury Risks Related to Onsite Components of Remedial Alternatives

Notes:

[1] Alternatives 5A and 5B primarily involve digging and hauling soils offsite. From 7 to 10 remediation workers (full-time equivalents) are expected to be onsite over the duration of the project (average of 8.5 workers).

[2] Alternative 6 involves excavating and relocating soils onsite and backfilling. From 10 to 25 remediation workers (full-time equivalents) are expected to be onsite over the duration of the project (average of 17.5 workers).

[3] Expected Number of Injuries or Illnesses at OU (u) = Average Incidence Rate (AIR) * Total Hours worked at OU (TH)

[4] Probability of injury or illness occurring during onsite components of remedial alternatives is calculated using the Poisson distribution methodology

$$\boxed{f(x) = (e^{-u} * u^{x}) / x!}$$

where x = the number of injuries and u = the expected number of injuries during the remedy period.

The probability of experiencing at least one injury or illness during the remedy period is then

$$\boxed{f(x \geq 1) = 1 - f(0) = 1 - e^{-u}}$$

[5] Source: U.S. Department of Labor, Bureau of Labor Statistics, Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types, North American Industry Classification System (NAICS) code 562. Rates converted from injuries per 200,000 hours to injuries per hour.

[6] Total Hours Worked at OU (worker hours) = Annual Average Number of Workers at OU x Work hours per year (2,000 hours/year) x Duration of Project (years)

[7] Annual worker hours during remedy period (worker hours/year) = annual average number of full-time workers at OU x 2,000 hours/year. The 2,000 hours/year represents a full-time equivalent (40 hours/week x 50 weeks/year).

[8] Annual average number of workers is an estimate of the number of full-time equivalent workers expected to work at the OU each year during implementation of the remedial alternative. The number of workers and/or full-time equivalents may vary according to selected contractor's proposed workplan and sequencing approach.

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Table A6-3 -- Fatality Risks Related to Truck Transportation Components of Remedial Alternatives

Alternative 5A: Total Removal and Offsite Disposal (without immobilization), Sheetpile Removal and Institutional Controls					
	Excavated Materials		**Fill**		**Total**
	Route A [1]	**Route B [2]**	**Route C [3]**	**Route D [4]**	
Expected Number of Fatal Crashes Involving Trucks Transporting OU-Related Materials (injury crashes/remedy period) [5] , u = AVIR x VM	0.0775	0.0601	0.0016	0.0026	0.142
Probability of at Least 1 Fatality Occurring during Remedy Period [6]	0.0745	0.0583	0.0016	0.0026	0.132
	1 in 13 chance	1 in 17 chance	1 in 627 chance	1 in 379 chance	1 in 7 chance
Average Vehicle Involvement Rate (fatal crashes/vehicle mile), AVIR	2.16E-08				
Vehicle Involvement Rate, Trucks in Fatal crashes per vehicle mile, NHTSA, 2008 [7]					
2003	*2.17E-08*				
2004	*2.22E-08*				
2005	*2.22E-08*				
2006	*2.14E-08*				
2007	*2.04E-08*				
Total Vehicle Miles Traveled by Trucks Transporting OU-related materials (vehicle miles/remedy period) [8] , VM = N x D	3,588,000	2,784,000	73,920	122,500	6,568,420
Number of Truck Trips Carrying OU-related material on the Designated Route (truck trips/remedy period)[9], N	31,200	69,600	9,240	3,500	113,540
Length of Designated Route (vehicle miles/truck trip), D	115	40	8	35	

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Table A6-3 -- Fatality Risks Related to Truck Transportation Components of Remedial Alternatives

Alternative 5B: Total Removal and Offsite Disposal (with immobilization), Sheetpile Removal and Institutional Controls					
	Excavated Materials		**Fill**		**Total**
	Route A [1]	**Route B [2]**	**Route C [3]**	**Route D [4]**	
Expected Number of Fatal Crashes Involving Trucks Transporting OU-Related Materials (injury crashes/remedy period) [5], u = AVIR x VM	0.082	0.064	0.002	0.003	0.150
Probability of at Least 1 Fatality Occurring during Remedy Period [6]	0.079	0.062	0.002	0.003	0.139
	1 in 13 chance	1 in 16 chance	1 in 627 chance	1 in 379 chance	1 in 7 chance
Average Vehicle Involvement Rate (fatal crashes/vehicle mile), AVIR	2.16E-08				
Vehicle Involvement Rate, Trucks in Fatal crashes per vehicle mile, NHTSA, 2008 [7]					
2003	*2.17E-08*				
2004	*2.22E-08*				
2005	*2.22E-08*				
2006	*2.14E-08*				
2007	*2.04E-08*				
Total Vehicle Miles Traveled by Trucks Transporting OU-related materials (vehicle miles/remedy period) [8], VM = N x D	3,818,000	2,944,000	73,920	122,500	6,958,420
Number of Truck Trips Carrying OU-related material on the Designated Route (truck trips/remedy period)[9], N	33,200	73,600	9,240	3,500	119,540
Length of Designated Route (vehicle miles/truck trip), D	115	40	8	35	

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Table A6-3 -- Fatality Risks Related to Truck Transportation Components of Remedial Alternatives

Alternative 6: Hazardous Waste Landfill Containment, Sheetpile Removal, Institutional Controls					
	Excavated Materials		**Fill**		**Total**
	Route A [1]	**Route B [2]**	**Route C [3]**	**Route D [4]**	
Expected Number of Fatal Crashes Involving Trucks Transporting OU-Related Materials (injury crashes/remedy period) [5], u = AVIR x VM	0	0.0256	0.0144	0.0027	0.043
Probability of at Least 1 Fatality Occurring during Remedy Period [6]	0	0.0252	0.0143	0.0027	0.042
	No chance	1 in 40 chance	1 in 70 chance	1 in 372 chance	1 in 24 chance
Average Vehicle Involvement Rate (fatal crashes/vehicle mile), AVIR	2.16E-08				
Vehicle Involvement Rate, Trucks in Fatal crashes per vehicle mile, NHTSA, 2008 [7]					
2003	*2.17E-08*				
2004	*2.22E-08*				
2005	*2.22E-08*				
2006	*2.14E-08*				
2007	*2.04E-08*				
Total Vehicle Miles Traveled by Trucks Transporting OU-related materials (vehicle miles/remedy period) [8], VM = N x D	0	1,183,600	667,200	124,600	1,975,400
Number of Truck Trips Carrying OU-related material on the Designated Route (truck trips/remedy period)[10], N	0	29,590	83,400	3,560	116,550
Length of Designated Route (vehicle miles/truck trip), D	115	40	8	35	

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Table A6-3 -- Fatality Risks Related to Truck Transportation Components of Remedial Alternatives

Notes:

[1] Route A – Exporting of excavated soils/residuals to a TSCA Landfill; From E Cork St., Kalamazoo MI to Wayne Disposal Inc., 49350 N Interstate 94 Service, Belleville, MI 48111 (115 miles per one-way trip)

[2] Route B – Exporting of excavated soils/residuals to a Non-TSCA Landfill; From E Cork St., Kalamazoo, MI 49001 to C & C Landfill BFI: 14800 P Dr. N, Marshall, MI 49068 (40 miles per one-way trip)

[3] Route C – Importing of clean sand fill for backfill/cover system; From Aggregate Resources, 4724 Ravine Rd., Kalamazoo, MI, 49006-1042 to E Cork St., Kalamazoo, MI 49001 (8 miles per one-way trip)

[4] Route D – Importing of clean topsoil for restoration/cover system; From 24 122nd Ave., Shelbyville, MI 49344-9710 to E Cork St., Kalamazoo, MI 49001 (35 miles per one-way trip)

[5] Expected Number of Fatal Crashes Involving Trucks Transporting OU-Related Materials (u; fatal Crashes/Remedy Period) = Average Vehicle Involvement Rate (AVIR) x Total Vehicle Miles traveled by trucks transporting OU-related materials during remedy period (VM)

[6] Probability of fatality occurring during transportation elements of remedial alternatives is calculated using the Poisson distribution methodology

$$\boxed{f(x) = (e^{-u} * u^{x}) / x!}$$

where x = the number of fatalities and u = the expected number of fatalities during the remedy period.

The probability of experiencing at least one fatality during the remedy period is then

$$\boxed{f(x \geq 1) = 1 - f(0) = 1 - e^{-u}}$$

[7] Data from National Highway Traffic Safety Administration. Involvement in Fatal Crashes and Involvement for Large Trucks, 1998-2008
Source: http://www-nrd.nhtsa.dot.gov/Pubs/811158.PDF

[8] Total Vehicle Miles (VM) = Truck Trips per Remedy Period (N) x Miles per truck trip (D)

[9] The estimated number of truck trips (N) is calculated based on the total volume of material to be transported divided by the capacity of each truck (50 tons) and then multiplied by 2 to account for round trip travel. N = total tons/truck capacity (50 tons) x 2 trips. Alternatives 5A and 5B primarily involve digging and hauling soils offsite. For Alternative 5A, there would be approximately 1,570,000 tons of TSCA material (Route A) and 950,000 tons of non-TSCA material (Route B). Because Alternative 5B involves adding 6 percent cement by weight to the material being transported offsite, the weights would be higher: 1,670,000 tons of TSCA material (Route A) and 1,000,000 tons of non-TSCA material (Route B). Both Alternatives 5A and 5B are estimated to require 231,000 tons of clean sand fill (Route C) and 87,500 tons of clean topsoil (Route D).

[10] The estimated number of truck trips (N) is calculated based on the total volume of material to be transported divided by the capacity of each truck (50 tons) and then multiplied by 2 to account for round trip travel. N = total tons/truck capacity (50 tons) x 2 trips. Alternative 6 involves excavating and relocating soils onsite and backfilling. For Alternative 6, no TSCA material would be transported offsite, but 740,000 tons of non-TSCA material would require offsite disposal (Route B). A total of 2,085,000 tons of clean sand fill (Route C) and 89,000 tons of clean topsoil (Route D) are estimated to be required.

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Table A6-4 -- Injury Risks Related to Truck Transportation Components of Remedial Alternatives

Alternative 5A: Total Removal and Offsite Disposal (without immobilization), Sheetpile Removal and Institutional Controls					
	Excavated Materials		**Fill**		**Total**
	Route A [1]	**Route B [2]**	**Route C [3]**	**Route D [4]**	
Expected Number of Injury Crashes Involving Trucks Transporting OU-Related Materials (injury crashes/remedy period) [5], u = AVIR x VM	1.3386	1.0386	0.0276	0.0457	2.450
Probability of at Least 1 Injury Occurring during Remedy Period [6]	0.7378	0.6461	0.0272	0.0447	0.914
	3 in 4 chance	2 in 3 chance	1 in 37 chance	1 in 22 chance	9 in 10 chance
Average Vehicle Involvement Rate (injury crashes/vehicle mile), AVIR	3.73E-07				
Vehicle Involvement Rate (injury crashes/vehicle mile), NHTSA, 2008 [7]					
2003	*4.08E-07*				
2004	*3.94E-07*				
2005	*3.69E-07*				
2006	*3.60E-07*				
2007	*3.35E-07*				
Total Vehicle Miles Traveled by Trucks Transporting OU-related materials (vehicle miles/remedy period) [8], VM = N x D	3,588,000	2,784,000	73,920	122,500	6,568,420
Number of Truck Trips Carrying OU-related material on the Designated Route (truck trips/remedy period) [9], N	31,200	69,600	9,240	3,500	113,540
Length of Designated Route (vehicle miles/truck trip), D	115	40	8	35	

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Table A6-4 -- Injury Risks Related to Truck Transportation Components of Remedial Alternatives

Alternative 5B: Total Removal and Offsite Disposal (with immobilization), Sheetpile Removal and Institutional Controls					
	Excavated Materials		**Fill**		**Total**
	Route A [1]	**Route B [2]**	**Route C [3]**	**Route D [4]**	
Expected Number of Injury Crashes Involving Trucks Transporting OU-Related Materials (injury crashes/remedy period) [5], u = AVIR x VM	1.4244	1.0983	0.0276	0.0457	2.596
Probability of at Least 1 Injury Occurring during Remedy Period [6]	0.7593	0.6666	0.0272	0.0447	0.925
	3 in 4 chance	2 in 3 chance	1 in 37 chance	1 in 22 chance	9 in 10 chance
Average Vehicle Involvement Rate (injury crashes/vehicle mile), AVIR	3.73E-07				
Vehicle Involvement Rate (injury crashes/vehicle mile), NHTSA, 2008 [7]					
2003	*4.08E-07*				
2004	*3.94E-07*				
2005	*3.69E-07*				
2006	*3.60E-07*				
2007	*3.35E-07*				
Total Vehicle Miles Traveled by Trucks Transporting OU-related materials (vehicle miles/remedy period) [8], VM = N x D	3,818,000	2,944,000	73,920	122,500	6,958,420
Number of Truck Trips Carrying OU-related material on the Designated Route (truck trips/remedy period) [9], N	33,200	73,600	9,240	3,500	29,885
Length of Designated Route (vehicle miles/truck trip), D	115	40	8	35	

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Table A6-4 -- Injury Risks Related to Truck Transportation Components of Remedial Alternatives

Alternative 6: Hazardous Waste Landfill Containment, Sheetpile Removal, Institutional Controls					
	Excavated Materials		**Fill**		**Total**
	Route A [1]	**Route B [2]**	**Route C [3]**	**Route D [4]**	
Expected Number of Injury Crashes Involving Trucks Transporting OU-Related Materials (injury crashes/remedy period) [5], u = AVIR x VM	0	0.442	0.249	0.046	0.737
Probability of at Least 1 Injury Occurring during Remedy Period [6]	0	0.357	0.220	0.045	0.521
	No chance	1 in 3 chance	1 in 5 chance	1 in 22 chance	1 in 2 chance
Average Vehicle Involvement Rate (injury crashes/vehicle mile), AVIR	3.73E-07				
Vehicle Involvement Rate (injury crashes/vehicle mile), NHTSA, 2008 [7]					
2003	*4.08E-07*				
2004	*3.94E-07*				
2005	*3.69E-07*				
2006	*3.60E-07*				
2007	*3.35E-07*				
Total Vehicle Miles Traveled by Trucks Transporting OU-related materials (vehicle miles/remedy period) [8], VM = N x D	0	1,183,600	667,200	124,600	1,975,400
Number of Truck Trips Carrying OU-related material on the Designated Route (truck trips/remedy period)[10], N	0	29,590	83,400	3,560	116,550
Length of Designated Route (vehicle miles/truck trip), D	115	40	8	35	

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Table A6-4 -- Injury Risks Related to Truck Transportation Components of Remedial Alternatives

Notes:

[1] Route A – Exporting of excavated soils/residuals to a TSCA Landfill; From E Cork St., Kalamazoo MI to Wayne Disposal Inc., 49350 N Interstate 94 Service, Belleville, MI 48111 (115 miles per one-way trip)

[2] Route B – Exporting of excavated soils/residuals to a Non-TSCA Landfill; From E Cork St., Kalamazoo, MI 49001 to C & C Landfill BFI: 14800 P Dr. N, Marshall, MI 49068 (40 miles per one-way trip)

[3] Route C – Importing of clean sand fill for backfill/cover system; From Aggregate Resources, 4724 Ravine Rd., Kalamazoo, MI, 49006-1042 to E Cork St., Kalamazoo, MI 49001 (8 miles per one-way trip)

[4] Route D – Importing of clean topsoil for restoration/cover system; From 24 122nd Ave., Shelbyville, MI 49344-9710 to E Cork St., Kalamazoo, MI 49001 (35 miles per one-way trip)

[5] Expected Number of Injury Crashes Involving Trucks Transporting OU-Related Materials (u; Injury Crashes/Remedy Period) = Average Vehicle Involvement Rate (AVIR) x Total Vehicle Miles traveled by trucks transporting OU-related materials during remedy period (VM)

[6] Probability of injury occurring during transportation elements of remedial alternatives is calculated using the Poisson distribution methodology

$$\boxed{f(x) = (e^{-u} * u^{x}) / x!}$$

where x = the number of injuries and u = the expected number of injuries during the remedy period.

The probability of experiencing at least one injury during the remedy period is then

$$\boxed{f(x \geq 1) = 1 - f(0) = 1 - e^{-u}}$$

[7] Data from National Highway Traffic Safety Administration. Involvement in Fatal Crashes and Involvement for Large Trucks, 1998-2008
Source: http://www-nrd.nhtsa.dot.gov/Pubs/811158.PDF

[8] Total Vehicle Miles (VM) = Truck Trips per remedy period (N) x Miles per truck trip (D)

[9] The estimated number of truck trips (N) is calculated based on the total volume of material to be transported divided by the capacity of each truck (50 tons) and then multiplied by 2 to account for round trip travel. N = total tons/truck capacity (50 tons) x 2 trips. Alternatives 5A and 5B primarily involve digging and hauling soils offsite. For Alternative 5A, there would be approximately 1,570,000 tons of TSCA material (Route A) and 950,000 tons of non-TSCA material (Route B). Because Alternative 5B involves adding 6 percent cement by weight to the material being transported offsite, the weights would be higher: 1,670,000 tons of TSCA material (Route A) and 1,000,000 tons of non-TSCA material (Route B). Both Alternatives 5A and 5B are estimated to require 231,000 tons of clean sand fill (Route C) and 87,500 tons of clean topsoil (Route D).

[10] The estimated number of truck trips (N) is calculated based on the total volume of material to be transported divided by the capacity of each truck (50 tons) and then multiplied by 2 to account for round trip travel. N = total tons/truck capacity (50 tons) x 2 trips. Alternative 6 involves excavating and relocating soils onsite and backfilling. For Alternative 6, no TSCA material would be transported offsite, but 740,000 tons of non-TSCA material will require offsite disposal (Route B). A total of 2,085,000 tons of clean sand fill (Route C) and 89,000 tons of clean topsoil (Route D) are estimated to be required.